MARKET ASSESSMENT OF 3Rs ACTIVITIES IN ONTARIO

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MARKET ASSESSMENT OF 3R'S ACTIVITIES IN ONTARIO

Report prepared for:

The Ontario Ministry of the Environment
Fiscal Planning and Economic Analysis Branch

Report prepared by:

Resource Integration Systems (RIS) Limited

In Association with:

VHB Research & Consulting Inc.

PIBS 2078

ACKNOWLEDGEMENT AND DISCLAIMER

This report was prepared for the Ontario Ministry of the Environment as part of a Ministry-funded project. The views and ideas expressed in this report are those of the author and do not necessarily reflect the views and policies of the Ministry of the Environment, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

ERRATA

An acronym for Industrial/Commercial/Institutional waste many appear in this report as ICI waste. This acronym should be read as "**IC&I**" waste.

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MARKET ASSESSMENT OF 3Rs ACTIVITIES IN ONTARIO

EXECUTIVE SUMMARY

It is estimated that in 1989, 9.8 million tonnes of municipal solid waste was generated in Ontario from both the residential and Industrial/Commercial/ Institutional (ICI) sectors, excluding hazardous waste, sewage sludge and scrap metal. The Ontario government has established waste diversion targets of 25% by 1992 and 50% by 2000, using 1987 as a base year. The assessment of 3R activities - reduce, reuse and recycling in place and projected, as of December 31, 1990 are not likely to divert sufficient quantities of waste to meet these targets. Based on the available data, a total diversion of 15% will be achieved by 1992, and 27% by 2000. New initiatives have been announced, but these have not been factored into the analysis.

These results are not definitive because there is no comprehensive database on waste generation, diversion and disposal. Estimates have been developed using per capita consumption information, industry shipments data, and waste composition statistics. Together they provide a reasonable, order-of-magnitude estimate of wastes.

The extent and effects of 3R activities in place and planned, particularly in the ICI sector, is not well-known as most of these wastes are managed privately. Recycling activities are most easily captured since these materials are processed and sold by weight. Reduction and re-use activities are not as amenable to measurement and their impacts on the waste stream are less obvious. Evidence and results of what's being done to reduce and divert waste is in many cases anecdotal and not readily extrapolated across all sectors. Many companies have begun some initiatives and are considering others. The lack of clear direction on a national basis (rather than fragmenting efforts to meet demands of individual local markets) particularly in the area of packaging, has meant that progress has been slow. They are therefore reluctant to commit to a particular direction (e.g. substitution of new lighter weight materials) since it may not be the "correct" way to proceed and product/packaging re-design is costly. Moreover, many companies believe that superiority in the management of product and packaging wastes will have competitive advantages. Hence, the overall conclusion reached in this study is that the targets are unlikely to be met, and therefore more careful review of the areas of weakness of the underlying data and information about generation and diversion rates is required.

More accurate data on waste generation and diversion are essential for policy decision-making. Measurement of waste at the point of disposal risks making the erroneous assumption that everything else is diverted. Good information is needed to know what is happening where and to assess how policy can increase diversion and to evaluate the effects policies have had relative to the established targets.

Markets for secondary material have existed historically.

Markets for many secondary materials are not new. In many commodity areas such as paper, markets for post-industrial paper fibre have existed for many years since these materials are in supply and there is demand. As a result, there is an established infrastructure of brokers and buyers as well as end users which will use these materials. What is new is the use of post-consumer secondary materials, which have often surged in supply as municipal recycling programs have come on stream. The result is an imbalance in supply and demand and a decrease in price.

For other commodities, limited or no secondary markets exist, such as for boxboard (used for cereal and detergent boxes), telephone books, disposable diapers etc. However, the pressure to take full responsibility for the wastes associated with a particular product, often referred to as product stewardship, is pressuring producers to assist in the development of 3Rs activities and markets to absorb and reprocess these materials. This study has identified areas where industry is individually or collectively taking such responsibility for market development.

There are specific areas where diversion is limited and substantial increases in waste reduction and recycling will be required to meet the targets.

The following material categories provide the largest opportunities for increased waste diversion initiatives:

- fine paper from the ICI sector
- magazines from both sectors
- boxboard from the ICI sector
- glass containers from both sectors
- plastic film from both sectors
- food waste from both sectors
- yard waste from the residential sector
- wood waste from the ICI sector

In developing initiatives to stimulate markets for the current and anticipated upsurge in the supply of secondary materials, existing markets and their operation should be recognized. This does not mean that some form of

government stimulus is not needed, rather the nature of the initiative and its impact on a well-functioning market should be carefully evaluated.

The government could undertake market development initiatives to stimulate market.

Specific initiative should be designed to accommodate increased volumes of post-consumer secondary materials which are expected to be generated and for which there is a need to reprocess these materials to divert them from the waste stream.

In order to achieve a 50% diversion of solid waste by 2000, a substantial level of market development activity will need to occur. The provincial government's role in stimulating markets may include:

- disseminating market information to suppliers and users of secondary materials;
- providing financial incentives to private industry to assist in the development of viable end markets;
- monitoring Ontario market development activities to ensure that Ontario supplies of post-consumer material are given preference;
- developing clear and equitable regulations for packaging and short term consumer goods waste diversion, including targets for recycling, reduction and reuse;
- instituting procurement guidelines favouring products made from post-consumer secondary materials, and encourage other levels of government to do the same.
- funding and encouraging research and development for innovative recycling technologies and means by which 3Rs activities may be enhanced.

1.0 INTRODUCTION

1.1 Background

In March 1990, Resource Integration Systems Ltd. and VHB Research and Consulting, Inc., as sub-contractors, were awarded a contract from the Ministry of Environment to conduct a Market Assessment of 3R's Activities. The findings of the study are to be used as input to a concurrent study, entitled "Coordination and Systems of a Socio-Economic Assessment of Waste Management Initiatives" specifically related to the achievement of the Ministry of Environment's stated objectives to divert 25% of the waste stream from landfill and incineration by 1992 and 50% to be diverted by the year 2000.

1.2 Objectives

The primary objective of the study, as stated in the terms of reference, is to confirm what municipal solid waste streams and quantities are currently amenable to each of the 3Rs - reduction, re-use and recycling. Specific waste materials were identified for assessment including papers, wood, glass, metals, construction/demolition materials, etc. A second purpose was to provide information on markets for these materials, particularly in terms of their current use of secondary materials, and the potential to enhance 3R's activities through increased market potential to use secondary materials. Within the context of this overall objective, this report provides:

- 1989 generation and diversion levels for materials in the municipal waste stream
- quantities of materials that could potentially be diverted from landfill and incineration for the years 1992 and 2000 given current market conditions in 1990
- an overview of markets for secondary materials
- options for increasing diversion rates to meet the government targets.

While the main focus is on markets for secondary material recovered from the municipal solid waste stream, reduction and reuse opportunities are noted where appropriate.

Throughout this study, the project team has attempted to obtain the most current information through reference to ongoing studies (e.g. waste composition of municipal solid waste), interviews with selected industry and government sources, and through the review of recent related reports.

For the purpose of this study, municipal solid waste is defined as total post-consumer waste from residential, commercial and industrial sources exclusive of the following:

- hazardous and liquid industrial waste as defined by Ontario's Regulation 309 under the Environmental Protection Act.

- household hazardous waste.
- municipal sewage sludge.
- industrial scrap metal.

1.3 Study Approach

The following describes the key tasks undertaken in order to complete the study.

1.3.1 Development of Database on Quantities of Secondary Materials in the Municipal Waste Stream and Recovery Levels for 1989

In order to estimate potential waste diversion rates for 1992 and 2000, information on the composition of the municipal solid waste streams and on current recovery levels were required. Precise quantities and composition of materials in the municipal solid waste stream in Ontario are not documented and therefore estimates are only possible at this time. The study team has relied upon the following sources of information:

- Ontario residential waste composition as documented in a concurrent study undertaken by CH_2M Hill Engineering Ltd. in association with MacLaren Engineers titled "A Study of the Physical and Economic Dimensions of Municipal Solid Waste Management in Ontario", 1991

- industrial/commercial/institutional (ICI) waste composition information was generated by contacting industry sources as much as possible since there is no definitive study of this nature for Ontario. In many instances, the ICI sector estimates are derived by netting the residential from the total consumption as provided from industry.

The CH_2M Hill residential waste stream composition study is based on a number of sources, including recent waste composition work undertaken by Gore and Storrie Ltd., for the Ontario Ministry of the Environment. CH_2M Hill estimates of residential waste composition before recycling for 1987 and 1989 are documented in Table 1.1. The specific source for each material is stated in the relevant chapter and accompanying references.

The primary differences between CH_2M Hill's numbers are due to differences in the estimation of ICI wastestreams by RIS to derive total wastes by commodity. CH_2M Hill used a "bottom up" approach by extrapolating waste stream composition data to derive provincial level totals. When RIS compared these to industry production and shipments data or new information and found variations, RIS used the industry numbers, e.g., ONP, and foundry sand. CH_2M Hill also relied on estimates generated by RIS, e.g., for plastics.

TABLE 1.1

ESTIMATED RESIDENTIAL WASTE GENERATION BY MATERIAL TYPE
IN ONTARIO IN 1987 AND 1989
(SOURCE: CH_2M HILL/ERL MODEL)

COMPONENT	1987		1989	
	Amount (tonnes)	Composition (%)	Amount (tonnes)	Composition (%)
PAPER				
Newspaper	650,200	16.66	673,200	16.61
Fine Paper	71,500	1.83	74,000	1.83
Boxboard	167,200	4.29	173,100	4.27
OCC	105,200	2.70	108,900	2.69
Magazines	159,500	4.09	165,100	4.07
Mixed Paper (waxed/plastic/mixed)	57,300	1.47	59,300	1.46
Phone Books	12,600	0.32	13,000	0.32
Composite Packaging	11,000	0.28	11,400	0.28
Other (kraft, wallpaper, tissue)	189,300	4.85	196,000	4.84
Subtotal	*1,423,800*	*36.49*	*1,474,000*	*36.37*
GLASS				
Food/Beverage Containers	259,300	6.65	268,500	6.62
Other	21,900	0.56	22,700	0.56
Subtotal	*281,200*	*7.21*	*291,200*	*7.18*
STEEL				
Food/Beverage Containers	72,500	1.89	75,100	1.85
White Goods	97,900	2.51	101,400	2.5
Other	54,400	1.39	56,300	1.39
Subtotal	*224,800*	*5.76*	*232,800*	*5.74*
ALUMINUM				
Beverage Containers	0	0.0	13,480	0.33
Other Containers	10,000	0.26	10,400	0.26
Foil (rigid and flexible)	2,800	0.07	2,900	0.07
Other	4,200	0.11	4,300	0.11
Subtotal	*17,000*	*0.44*	*31,100*	*0.77*

TABLE 1.1 (cont'd)

ESTIMATED RESIDENTIAL WASTE GENERATION BY MATERIAL TYPE
IN ONTARIO IN 1987 AND 1989
(SOURCE: CH_2M HILL/ERL MODEL)

COMPONENT	1987		1989	
	Amount (tonnes)	Composition (%)	Amount (tonnes)	Composition (%)
PLASTIC				
PET Bottles	3,700	0.09	3,800	0.09
HDPE Bottles	11,100	0.28	11,500	0.28
Other Rigid	108,100	2.77	111,900	2.76
Film	120,700	3.09	125,000	3.08
Subtotal	*243,600*	*6.24*	*252,200*	*6.22*
ORGANICS				
Food Waste	603,300	15.46	624,200	15.41
Yard Waste (leaves, grass & weeds)	472,800	12.12	489,300	12.08
Yard Waste (brush)	159,300	4.08	164,900	4.07
Subtotal	*1,235,400*	*31.66*	*1,278,400*	*31.56*
Wood Waste	45,100	1.16	46,700	1.15
CONSTRUCTION AND DEMOLITION				
Drywall	11,100	0.28	11,500	0.29
Other	50,300	1.29	52,100	1.29
Subtotal	*61,400*	*1.57*	*63,600*	*1.57*
DIAPERS	107,200	2.75	111,000	2.74
USED TIRES	800	0.02	800	0.02
HHW	22,600	0.58	23,400	0.58
OTHER	239,000	6.13	247,400	6.10
TOTAL	**3,901,900**	**100.0**	**4,053,200**	**100.0**
POPULATION	9,271,500		9,598,600	
GENERATION RATE (kg/cap/year)	421		422	

TABLE 1.2

ESTIMATED ICI WASTE QUANTITIES GENERATED IN ONTARIO BY WASTE COMPONENT IN 1987 AND 1989
(SOURCE: CH_2M HILL/ERL MODEL)

Component	Estimated Quantity Generated (tonnes)	
	1987	1989
OCC	450,000	441,000
Office Paper	345,000	354,000
Other Paper	424,000	426,000
Wood	1,114,000	1,130,000
Glass	279,000	282,000
Plastic	167,000	163,000
Organics	568,000	600,000
Metal	558,000	599,000
Tires	82,000	88,000
Other	1,202,000	1,278,000
Total	**5,189,000**	**5,361,000**

TABLE 1.3

SUMMARY FOR TARGETED WASTE CATEGORIES OF 1989 RESIDENTIAL AND ICI WASTE GENERATION ESTIMATES (SOURCE: RESOURCE INTEGRATION SYSTEMS)

	Residential	ICI
	(tonnes)	
PAPER		
• Old Newspapers	400,000	170,000
• Fine paper	74,000	360,000
• Boxboard	173,100	333,900
• Corrugated cardboard	109,000	441,200
• Magazines	165,100	127,660
• Telephone directories	13,000	7,300
• Mixed paper	59,300	79,400
GLASS		
• Food and beverage containers	268,500	61,500
STEEL		
• Food and beverage containers	75,100	24,600
ALUMINUM		
• Beverage containers	13,500	15,400
• Foil	2,900	1,300
PLASTIC		
• HDPE bottles	17,440	21,770
• PET bottles	3,540	390
• Other rigid containers	15,360	23,180
• Film	101,260	56,960
FOOD WASTE	624,600	490,000
YARD WASTE		
• Leaves, grass, brush, prunings	654,400	110,000
WOOD WASTE	46,700	1,439,700
CONSTRUCTION/DEMOLITION WASTE		
• Drywall	11,500	129,600
SCRAP TIRES	800	88,200
DISPOSABLE DIAPERS	111,000	8,000
FOUNDRY SAND	0	356,000

Tables 1.1 and Tables 1.2 are the waste generation estimates provided by CH_2M Hill/ERL. These and the estimates of RIS were evolving as better information became available and accounts for the slight differences between the two sets of numbers.

For the purposes of this study the research team has not considered all municipal residential waste stream components as identified on Tables 1.1 and 1.2. Those waste categories targeted for consideration in this study are listed in Table 1.3.

Once residential waste composition figures had been provided by CH_2M Hill for 1989, diversion levels were estimated based on information about policies in place as of 1989 such as the blue box program and the National Packaging Protocol (NAPP), and through discussions with industry.

1.3.2 Assessment of Waste Diversion Potential in 1992 and 2000 for Targeted Materials in the Municipal Solid Waste Stream

Within the context of this overall study, an assessment was undertaken of potential waste diversion for targeted materials for 1992 and 2000. The assessment shows waste diversion potential based on current recovery and reduction techniques and trends; it identifies short falls from the Ministry of Environment objectives of 25% and 50% diversion in 1992 and 2000 respectively; and, finally it identifies possible options for stimulate markets to increase diversion.

For the purposes of projecting residential material recovery from blue box programs, the study assumes that the number of households with blue boxes will increase from the 1989 year end level of just over 2 million to 2.9 million in 1992 and 3.5 million in 2000 (based on discussions with Ontario Multi-Material Recycling Inc. (OMMRI)).

Projections of material generation and recovery for both the residential and ICI sectors have taken into consideration growth in population to 10,022,000 in 1992 and 10,896,000 in 2000 (population figures supplied by MOE – see Appendix B for details on determining 1992 and 2000 population and households for municipalities in Ontario) and assumes residential per capita generation of 422 kg (CH_2M Hill 1989 figure) and an ICI per capita generation of 550 kg per capita for both 1992 and 2000. It should be noted that CH_2M Hill's final ICI generation figure is actually 555 kg per capita however the difference was considered insignificant given the level of accuracy with which we are dealing.

1.3.3 Identification and Characterization of Markets for Ontario Secondary Materials

The project team has compiled existing data on secondary materials markets in Ontario, Quebec, and adjacent U.S. states. In addition, information has been obtained on markets for selected materials for which little market history exists.

For each market category, the following information has been provided:

- the number and location of firms
- current and planned capacity
- price ranges
- quality specifications

This data has been used to estimate demand, supply, and cross price elasticities to the extent that the data allow. As well, estimates of elasticities from published studies have been identified through the a computerized literature search. The study team has interviewed key personnel for each secondary material from both demand and supply sides of the market in an attempt to derive price elasticities for 1992 and 2000.

The study begins with an introduction to the theory and evidence on secondary materials markets (Chapter 2). Chapters 3 through 18 profile generation, recovery and end markets for each specific material. Finally, Chapter 19 draws conclusions about the status of these markets and the potential role of government initiatives to stimulate their development.

2.0 *CHARACTERISTICS OF MARKETS FOR SECONDARY MATERIALS*

2.1 *Supply of Secondary Materials*

This section of the report provides a brief overview of the generic factors affecting supply and demand for post-consumer secondary materials from the municipal waste stream. It also considers aspects of the market structure that affect the supply and demand.

For the purposes of this study, there is an upper limit on the amount of secondary material that could be recovered from the waste stream for recycling. This is referred to as potential supply. The quantity of materials recycled will depend on price and a number of other factors which are reviewed. Demand refers to the amount of secondary material required by processors of secondary material. In some cases, the market may be intermediate processors that reprocess the material and ship to end users (e.g. newsprint de-inking mills), while in other cases the market may be the end users directly (e.g. the glass container industry). As with supply, demand varies with a number of factors, and these are discussed below.

Post-consumer material refers to material that has been utilized for its intended purpose and is ready to be discarded. Consumers include households in the residential sector as well as businesses and institutions in the ICI sector.

When the user of a material has no further use for it, it enters the waste stream where it can be diverted from disposal by re-use or recycling to become a secondary material. There are several possible destinations for these secondary materials: they can be reused, or as is often the case, be recycled through reprocessing. Which of these is chosen is determined by a variety of factors, each of which is considered below.

2.1.1 Production and Consumption of Materials

The availability of materials to be recycled is constrained by the production or consumption of goods no longer needed. For example, the quantity of glass available for recycling will not exceed the quantity of glass consumed (on average). The maximum supply of secondary materials is described by Equation 1.

$$MS = MP + (M_i - M_O) + (S_i - S_O) + (C_i - C_O) - L$$

Where MS is the quantity of secondary materials
MP is the quantity of materials used in products
M_i is the quantity of materials imported
M_O is the quantity of materials sent out of the province
S_i is the quantity of materials removed from stock
S_O is the quantity of primary materials added to stock
C_i is the quantity of materials converted from some other material type
C_O is the quantity of primary materials converted from some other material type
L represents losses during use

Equation 1: The total quantity of secondary materials potentially available in any period of time. (potential supply)

Information for all of the items indicated in this supply equation are not always available. It may be simpler to estimate the total quantity potentially available from waste composition studies as was done by CH_2M Hill as part of the Ministry's concurrent socio-economic studies on municipal solid waste initiatives, and used frequently in this report. Alternatively, waste generation can be estimated from consumption data using industry shipments statistics. This method has also been used as appropriate in this study.

Nonetheless, it is clear that there is a maximum quantity of materials potentially available for recycling, and in many cases this quantity will be determined primarily by the quantity of material used in products.

2.1.2 Capacity of Collection Programs and Processing Facilities

It may only be possible to collect a fraction of the total of secondary materials potentially available due to constraints in the capacity of collection programs and processing facilities. For example, most residential curbside programs use specialized segmented trucks for collection of recyclables. If there was a dramatic increase in the quantity of materials put out for collection, or if the decision was made to extend the geographic scope of the program, the available capacity of trucks for collection may be inadequate to handle the increased volume.

New vehicles can always be purchased, or new processing capability added. However, doing so may take time. In theory, the availability of capacity for collection or processing will normally be a short-term problem which can be resolved by purchasing and installing the necessary equipment. However, in practice, capacity availability interacts with other factors, such as the revenues derived from the prices of secondary materials—recycling program operators may be reluctant to add capacity because of concerns about the prices paid for secondary materials, particularly if diversion costs (collection plus avoided disposal costs) exceed revenues. In this example, regardless of what happens to prices for secondary materials, the failure to install capacity may be the constraint on the supply of secondary materials for recycling.

2.1.3 Collection and Processing Costs for Recycling

The economic attractiveness of recycling will be affected by the costs of collecting, processing and transporting secondary materials to markets. Separation of recyclables at source requires additional inconvenience, and storage space. In addition, costs of collecting separated material can be expected to be higher than collection costs for mixed refuse as evidenced by municipal operators complaints about the operating costs of curbside programs.

Some spatial variation in the economic attractiveness of recycling can be expected. Particularly for low value, low density materials (like glass, for example), the costs of transportation may be very significant, and the attractiveness of recycling will decline as distance to users of cullet increases.

2.1.4 Disposal Costs

The economic attractiveness of recycling is also directly affected by landfill tipping fees (avoided disposal costs). Historically waste disposal services were available at no or insignificant cost, and "economics of recycling" were determined largely by prices paid for secondary materials and collection and processing costs. Now, however, waste management is an expensive service. Tipping fees in some landfills exceed 100 $/tonne, set as a deterrent price or for revenue generation purposes rather than being a cost-based price. If tipping fees are closer to diversion costs (i.e. recycling) then the economics should favour recycling over landfill.

2.1.5 Other Influences on the Choice Between Disposal and Recycling

The choice between disposal and recycling is based on financial, economic and other considerations. A significant and growing component of the supply of secondary materials is from public sector sources (i.e. municipal collection), and in choosing between disposal and recycling these suppliers may include considerations of external costs (like resource impacts), public preferences and constraints on the availability of landfill capacity. For example, some regional municipalities have enacted bans on certain high volume materials (e.g. corrugated cardboard, wood waste) from their landfills in order to conserve landfill capacity and to force private sector generators to initiate recycling activity.[1]

2.1.6 Price Offered for Secondary Materials

Finally, the supply is likely to be affected by the price offered by reprocessors. All other things being equal, as the price paid for secondary materials increases, the economic attractiveness of recycling increases, and sources of secondary materials that were previously uneconomic become economic. The relationship between the price paid and the quantity available is known as the *supply curve.* A generic supply curve is illustrated in Figure 2-1.

Methodologies for modelling the supply decisions of municipal agents are still evolving. Several innovative techniques are embodied in this report. The literature review was of limited usefulness in developing these techniques because of the relatively recent entry of municipalities into the market and the uniqueness of the Ontario situation. However, the studies referenced in section 2.4 by Bingham, Cooley & Youngblood (1983), and Research Triangle Institute (RTI) for the U.S. EPA (in progress) are worthy of note.

Using engineering data on a number of solid waste disposal and materials recovery options, Bingham, Cooley and Youngblood attempted to estimate the elasticities of supply (as well as prices) for paper, glass, ferrous metals, aluminum and energy recovered from U.S. municipalities. Their key assumption was that the municipalities would attempt to minimize net disposal costs. Their findings are of limited relevance to the Ontario situation because only centralized materials recovery techniques were examined. In particular, collection costs were ignored in the analysis.

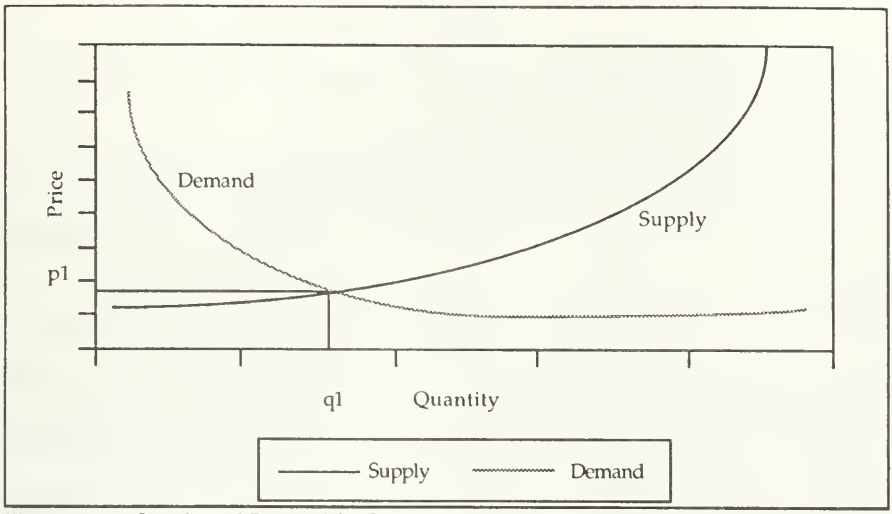

Figure 2-1 Supply and Demand for Secondary Materials

The own-price and cross-elasticities of supply estimated by Bingham, Cooley and Youngblood are shown on Table 2-1 For example, the own-price elasticity of supply for aluminum is 0.730 and the cross-price elasticity with respect to steel is 0.251. This means that a 10 per cent increase in the price of aluminum would result in a 7.3 per cent increase in the supply. The strong cross price effect with respect to steel shows that to a certain extent, similar facilities are required to separate aluminum and steel from solid waste and so a 10 per cent increase in the price of steel would result in a 2.51 per cent increase in the supply of aluminum. The supply curve described by the elasticities below is a long run supply curve in which suppliers can add capacity. The values are only accurate to the extent that the costs of the various materials recovery techniques and the behaviour of municipal decision makers and consumers are accurately estimated by the model.

In contrast with the Bingham, Youngblood and Cooley study, RTI's recent study for the EPA does not assume that municipalities will attempt to minimize disposal costs in their choice of recycling programs. Instead they assume that the choices made by municipalities in the near future will be very much like the choices made by similar (in terms of size and population density) municipalities in the recent past. In other words, they assume that the future distribution of choices across the range of available options will be similar to the past distribution of such choices.

Table 2-1

Elasticities of Supply for Secondary Materials Recovered from Municipal Solid Waste

	A 1% increase in the price of				
Increases the supply of	Paper	Glass	Steel	Aluminum	Energy
Paper by	1.05%	0.0%	0.0%	0.0%	0.0%
Glass by	0.029%	0.165%	0.155%	0.151%	0.013%
Steel by	0.051%	0.047%	0.372%	0.240%	0.056%
Aluminum by	0.037%	0.041%	0.251%	0.730%	0.042%
Energy by	-0.80%	0.002%	0.019%	0.020%	0.234%

Source: Bingham, Youngblood, and Cooley (1983, 176)

The recent emergence of municipalities (rather than waste collectors/brokers) as the most significant suppliers of many secondary materials has weakened the justification for focusing upon price as the most important determinant of the quantities of secondary materials supplied. It seems inappropriate to assume that price or profit is the major factor in the decision-making process of municipal agents. Factors such as public or legislative pressure requiring diversion of solid waste from landfill (which effectively increases the avoided costs of disposal), waste generation rates and the fact that recycling programs are viewed primarily as a form of waste management rather than revenue generation will probably all combine to ensure that municipal supply is less responsive to changes in price than was supply from previous sources. However, initial choices of materials recovery techniques will almost definitely take expected revenues and costs into account. Thus, cost-based supply curves may still be appropriate when considering the medium to long run.

2.2 *Demand for Secondary Materials*

Recovering materials from the waste stream is only the first step in recycling. Firms which are willing to complete the recycling equation by using secondary materials in the production of new products constitute the players in the secondary materials market. The demand for secondary materials is a function of demand for the final products in which they are used. This is known as *derived demand*.

2.2.1 Demand for Products Using the Material

Demand for the final product is often the most significant influence upon the demand for secondary materials. Demand for the final product will also be the most significant influence upon demand for secondary materials if they are materials of last resort, i.e. they are only used in periods in which there is a shortage of primary production capacity. In support of this hypothesis, Deadman, Turner and Grace (1978), Gill & Lahiri (1980) and Kinkley & Lahiri (1984) found price to be statistically insignificant as a determinant of demand for wastepaper. Parameters related to the demand for woodpulp and mill products were found to be more significant.

The demand for products which might use secondary materials constrains the demand for those secondary materials. If picnic tables are being made out of Tetra-Paks, the demand for picnic tables sets an upper limit on the demand for Tetra-Paks for reprocessing into picnic tables.

2.2.2 Available Processing Capacity

The elasticity of demand (i.e. the responsiveness of demand to a change in price) will vary depending upon whether or not it is considered over the short or long run. In the short run, little or no investment in new technology or capacity is possible and so demand is likely to be fairly inelastic. However, in the long run, greater substitution is possible since old equipment can be allowed to depreciate, and then replaced with different technology, or capacity embodying new technology can be added to accommodate increased demand. In very capital-intensive industries, (e.g. pulp and paper) the nature of installed capacity (whether or not it is easily adapted to the use of secondary materials) will be a significant determinant of the short-run demand for secondary materials and so demand is likely to be relatively inelastic.

If firms are unable to process secondary materials, they are unlikely to want them (except possibly to build up an inventory in anticipation of capacity coming on stream). Again this is presumably a short-term phenomenon — if processing is economically attractive, the capacity will be installed, but it cannot be done so immediately.

The location of this processing capacity is also important since this impact on transportation costs.

2.2.3 Prices of Secondary Materials Compared to Prices of Primary Materials

The cost of the materials — whether primary or secondary — is a major influence on the quantity demanded. The user of the materials faces various costs depending on whether the material is from primary or secondary sources. A user will be more inclined to accept secondary materials if the price difference paid for them offsets any additional costs.

2.2.4 Processing Costs of Secondary Materials Compared to Processing Costs of Primary Materials

Another influence on the quantity demanded will be the differences in processing costs. Processing costs are a function of the type of technology required to process the material. For some materials, like glass, the same technology may be used for primary and secondary materials. Using a mixture of primary and secondary materials will, however, result in some additional storage and handling costs. For other materials, like newsprint or aluminum, different technologies are used and the costs of these are likely to be different than the costs for using primary materials.

In addition to the average unit costs being different, technologies for using primary and secondary materials may have different degrees of capital intensity. This may influence the choice of technologies when production is below capacity, for example, aluminum production from primary materials using a continuous process which is very capital intensive and is difficult to start–up and shut–down. Alternatively, secondary smelters use batch operations. When production is below capacity, it is more attractive to maintain full capacity at the primary smelters and shut down the secondary ones.

2.2.5 Other Differences Between Primary and Secondary Materials

Other differences that might favour primary over secondary materials (or vice versa) include the security of supply, and quality considerations.

Security of supply is a crucial concern of any manufacturer, and most will pay a premium to ensure that interruptions are avoided. This may have the effect of favouring primary over secondary materials, especially where long-term supply contracts cannot be arranged.

Similarly, material users may have particular quality requirements that are easier to meet with materials from some sources than materials from others. For example, if the material from a particular source is contaminated (i.e. relative to primary material), then specialized monitoring technologies or equipment or specialized processing equipment may be required. Even if the level of contamination is acceptable, if the type of contamination varies, then special monitoring or processing technologies may be required, at increased cost.

2.2.6 Prices that can be Charged for Products made with Secondary Materials

Finally, the quantity demanded will depend on the marketability of the product. If consumer preferences encourage or discourage the use of secondary materials, this will affect the price that producers can charge, and the economic advantages or disadvantages of using primary or secondary materials.

Consumer preferences, as evidenced by their willingness to pay, are important in assessing the market potential for secondary materials. Traditionally, "new" goods made with "used" or "waste" materials were sometimes considered by consumers to be less preferable, and could only be sold if a price advantage was offered. More recently, there has been a shift in the preferences of some consumers toward goods manufactured with secondary materials, so that what was previously considered irrelevant or negative is now sometimes seen as being positive, and premium prices can be demanded.

In either case — whether the demand exists because of price advantages or preferences for products with recycled content — the demand for secondary materials will depend on the demand for products containing them.

2.3 *Market Structure and Balancing of Supply and Demand*

2.3.1 Market Structure

Scope of Market

The geographic scope of the market will be important in determining how the market operates, and the opportunities for government intervention. The geographic scope of the market will be determined by such things as production economies of scale, and levels of demand for the products, and the significance of transportation cost to overall cost. For many materials, including aluminum and newspaper, the scope of the market is at least continental, if not global.

Relatively valuable secondary materials such as aluminum, many paper grades and some plastic resins can economically be transported to export markets. Foreign demand will depend upon transportation costs, market conditions in the foreign country and any barriers to trade that might exist between the two countries. Grace, Turner, and Walter (1978, 1979) and Yohe (1979) suggest that international trade can help to stabilize the prices of secondary materials.

The scope of the market is an important consideration in determining whether public sector incentives or disincentives are likely to be effective. If prices are determined on the global stage, it is unlikely that Ontario will be able to exercise much influence over them.

Participants in Market — Numbers and Type

Market functioning may be different if there are many companies than if there are few, or if companies are vertically integrated.

Where there are relatively few participants in a particular market, the firm with the lowest price preference may be able to exercise control over prices.

Similarly, the market may be more easily controlled by a firm or a small number of firms if they are vertically integrated. Vertical integration in the materials industries is often seen as desirable to ensure security of supply. This is particularly important in industries with high capital costs that are very sensitive to down-time due to material shortages.

A great deal of the literature on industrial organization is devoted to measuring how great an influence market structure can have upon firm conduct and firm or industry performance. Two issues examined in this literature are particularly relevant to the assessment of markets for secondary materials. These are:

- What real or perceived benefits encourage firms to engage in horizontal integration of primary and secondary production and vertical integration into the collection and sorting of recyclable materials? and

- What are the implications of such integration?

Industries producing and using primary products have historically tended to be oligopolistic and dominated by large vertically-integrated firms. Secondary industries have tended to be smaller, more competitive and less vertically-integrated (Page, 1977; Grace, Turner and Walter, 1978). Recently however, there has been a trend towards integration of primary and secondary production and towards vertical integration by secondary producers into the recovery of secondary materials (see for example the glass, aluminum, and drywall industries in Ontario).[2]

Much of this integration can probably be explained as a reaction to the waste diversion legislation, disposal bans, and tipping fee increases that have lowered the prices of many secondary materials in several Canadian and American jurisdictions. These events are expected to increase the returns to members of industries producing and using recycled materials, and so, according to standard economic theory, entry into the industry will occur until excess profits are competed away.

Firms engaged in primary materials-based production usually face the lowest barriers to entry into the same secondary materials-based production. They often possess real cost advantages over other potential entrants because of complementarities in the production processes, distribution networks, or managerial expertise required by both types of firms. For example, in cases in which primary and secondary materials are almost perfect substitutes, firms engaged in primary materials-based production will have the advantage of

not having to make risky investments in new production capacity in order to use secondary materials. Even in cases in which primary materials-based production processes cannot be easily adapted to use secondary materials, firms engaged in primary materials based production may have the advantage of greater relevant managerial expertise. Furthermore, these firms may be able to sell products containing secondary materials through existing channels and thus avoid new investment in distribution networks and sales personnel.

Firms engaged in secondary materials-based production are among the most likely entrants into secondary materials recovery because there are often significant benefits associated with vertical integration. Vertical integration reduces transactions costs (costs incurred by using the market) by internalizing economic activity within the firm. In markets for secondary materials, the risk caused by price volatility and uncertainty of supply represent a substantial transaction cost.

The literature also notes that vertical integration might be used to increase the market power of the integrated firm (Blair and Kaserman, 1978). A small but highly specialized body of industrial organization literature has focused on the implications of horizontal or vertical integration into secondary materials markets by monopolistic primary producers.[3] The findings of one of these studies are particularly interesting in light of the structure of some primary and secondary materials industries in Ontario (e.g. aluminum).

Hollander and Laserre (1988) found that if the cost of recycling was higher than the cost of primary production,[4] a monopolistic primary producer could maximize its profits by preempting entry into secondary production (by repurchasing all available scrap). They found that such entry preemption would cause price of both final products and secondary materials to rise since the monopolist would be forced to bid up the price of scrap.

One caveat which must be applied to this finding is that it is only completely valid within the rigorous specifications of the authors' theoretical model. Economists are still uncertain of how to model firm behaviour in oligopolistic industries.

Maturity of Market

The maturity of the market is an important determinant of potential supply and demand of secondary materials.

Characteristics of a mature market might be expected to include:

- availability of processing technologies, and confidence in their effectiveness.

- knowledge about the quality of secondary materials, and the implications on their salability and usability.

- in–place mechanisms to ensure security of supply, and possibly mechanisms to dampen price fluctuations.

For example, a constraint to the greater recycling of food waste as compost is the lack of demonstrated technologies in Ontario, and possible concerns of potential compost users about the suitability of compost as a substitute for products produced from primary materials.

As already discussed, contamination in secondary materials is a concern of users of these materials. In mature markets, suppliers can be expected to recognize the quality concerns of users, and ensure that these are satisfied; users can have confidence in the quality of the secondary materials they purchase, and know what kinds of contamination to expect and at what levels.

Particularly where use of secondary materials requires considerable capital expenditures, users will want to ensure that they will have adequate access to secondary materials to enable them to prevent their capital equipment from sitting idle. In mature markets, this may be achieved by the presence of a large number of potential suppliers, or vertical integration (whether by acquisition or through long–term contracts).

Again to ensure stability for both suppliers and users, mature markets might be expected to have in place mechanisms to dampen fluctuations in prices, and to create greater certainty within the marketplace.

In summary, in mature markets suppliers can be expected to continue supplying secondary materials meeting known quality criteria, and users can rely on having access to these materials at reasonable cost. This decreases the risks to all involved of participating in the secondary materials market.

2.3.2 Balancing Supply and Demand

Prices and Quantities

The quantity demanded and that supplied will vary with the price of secondary materials. At low prices, one expects demand to be high and supply to be low; at high prices one expects supply to be high and demand to be low. The market equilibrium occurs at the price at which demand and supply are equal, at point q1, p1. This is illustrated in Figure 2-1.

Demand Functions

Econometric methods can be used to estimate demand and supply functions and their corresponding elasticities. However, Page (1977, 47-48) suggests five reasons why econometric analysis may be less than successful when applied to secondary materials markets:

- the poor quality of price and quantity data.
- the dynamic short-run nature of the supply for most secondary materials.
- the importance of technological change in many of the industries and the difficulties in accounting for this using econometric methods.
- important non–linearities (which are also difficult to model using econometric methods) in the supply of secondary materials.
- the distorting effects of government programs and policies.

Holmes (1988) also notes that the use of a single parametric value such as an elasticity of substitution to describe the relationship between input prices and demand presumes that the relationship between price and substitution is both continuous and reversible. However, this presumption may be unwarranted since:

- certain substitution decisions may be irreversible.
- the relationship between input prices and demand may be discontinuous and demand might be unresponsive to price within

certain ranges if only a few different production technologies are available.

The demand function for secondary materials can be estimated using econometric methods. To do so, a regression analysis is performed with quantity demanded as the dependent variable and with parameters such as the material's own price, the price and output of the final product, the price and output of competing primary materials and primary production capacity as the independent variables.[5]

Attempts to estimate the elasticity of demand for certain secondary materials have been made by Anderson and Spiegelman (1977), and Russell & Vaughan (1976). These are summarized in Table 2.2 and Table 2.3. Kinkley and Lahiri and Gill and Lahiri found the price of wastepaper to be a statistically insignificant parameter in their demand functions (implying a zero own-price elasticity). These results are now somewhat dated and so technological changes, and the effects of government policy must be taken into account.

Table 2.2

Elasticities of Demand for Secondary Materials

Material	Country	Years	Elasticity
Wastepaper	USA	1962 - 1974	0.08
Ferrous Scrap	USA	1962 - 1972	-0.64

Source: Anderson and Spiegelman, 1977.

Table 2.3

Estimates of the Elasticities of Demand for Ferrous Scrap in the USA

Plant Type	Cross-Elasticity of Demand Between Scrap and Iron Ore
Open Hearth	0.52
Basic Oxygen	0.03
Basic Oxygen/Electric Arc Combination with 100% Excess Capacity	0.39

Source: Russell and Vaughan (1976, 242)

Future demand can also be estimated by relating forecasts of the production of final products to technical input-output coefficients for secondary materials. Specifically, the matrix of technical coefficients is multiplied by a final demand vector to produce the estimate of future demand. Turner, Grace and Pearce (1977) employed this approach to estimate future demand for wastepaper in the EEC, the United Kingdom, and the USA.

Supply Functions

The elasticity of supply of a product measures the degree to which supply varies in response to changes in the price of the good.[6] In the secondary material market, the extent to which the curves apply depends on the substitutability of the secondary material for primary materials. If the two are not substitutes at all, then the prices and quantities of primary materials available will have no effect on the supply and demand curves. If they are perfect substitutes, then the curves in will apply, but the supply curve is the supply curve not just of secondary materials, but of both primary *and* secondary materials.

In most cases, however, scrap materials cannot serve as perfect substitutes for primary materials, but they are not completely independent. Rather, the demand for secondary materials will change in response to changes in the price of primary materials. This is known as the *cross elasticity of demand.* This is a measure of how demand in one market (say the secondary material market) changes in response to changes in price in another market (say the primary material market).

Cross-price elasticities, often referred to as simply "cross elasticities", relate the change in the demand for a good to changes in the price of other goods.[7] They measure the percentage change in demand for good *i* resulting from a change in the price of good *j*. A positive cross elasticity usually indicates that goods *i* and *j* are substitutes because a rise in the price of *j* results in a decrease in its consumption and its substitution by good *i* (the relatively cheaper good). (For example, a rise in the price of primary aluminum may result in a change in the demand for secondary aluminum.)

Cross elasticities for certain secondary materials have been estimated by Anderson & Spiegelman, the Environmental Law Institute, Gill & Lahiri and Russell & Vaughan.[8]

Table 2.4

Review of Published Estimated of Cross-Elasticities of Demand for Secondary Materials

Author	Material	
	Wastepaper	Ferrous Scrap
Anderson & Spiegelman	0.17	1.14*
Environmental Law Institute	0.13	0.28
Gill & Lahiri	0.20	— —

* *Elasticity with respect to steel production rather than prices.*

Using engineering data, Russell and Vaughan (1976) estimated cross-elasticities of demand between scrap and iron ore in the United States for three different types of plants. Their estimates are shown on Table 2-5.

Table 2.5

Cross-Elasticities of Demand Between Ferrous Scrap and Iron Ore

Plant Type	Cross-Elasticity of Demand Between Scrap and Iron Ore
Open Hearth	0.52
Basic Oxygen	0.03
Basic Oxygen/Electric Arc Combination with 100% Excess Capacity	0.39

Source: Russell and Vaughan (1976, 242)

Hierarchy of Uses, and Material Substitutions

As markets evolve, some users of secondary materials will displace others, and changes in the composition or demand for particular products may occur. That is, in any given use, a different material may be substituted for the material originally used. For example, as deinking capacity is installed, old newspapers may be drawn away from boxboard manufacturing, and used to displace primary newsprint pulp.

Elasticity of substitution is a measure of the extent to which the ratio of inputs used in a production process changes in response to a change in the relative prices.9 With production processes capable only of a fixed input ratio, input ratios will not change in response to relative price changes and the elasticity of substitution will equal zero. With more flexible production processes, the elasticity of substitution is greater.

No estimates of elasticities of substitution between primary and secondary materials were found in the literature although such analyses have been performed for a number of raw materials and other factors of production.[10] One major obstacle to performing a similar analysis involving secondary materials is the poor quality of the available price and quantity data. (For example, published prices are often f.o.b. the recycler's facility and exclude transport costs.) Holmes (1988) identifies a number of additional problems with such analyses, three of which might be particularly relevant in the case of many secondary materials. He argues that the following factors play important roles in materials substitution but cannot be adequately accounted for using econometric techniques:

- relative input prices may influence technical innovation by inspiring research and development aimed at economizing upon the relatively expensive factor of production. [11]

- uncertainty of supply can reduce demand for a given input, particularly when substitution decisions are not easily reversible.

- consumer attitudes (such as a preferences for, or aversion to, recycled material content) might play an important role in final product demand and hence substitution decisions.

2.3.3 Policy Options for Meeting Government Objectives

Policy options available fall into three main types—regulatory command and control; economic incentives and disincentives; and information and moral suasion. Which type, and which specific measure is likely to be effective in any given situation will depend on demand and supply considerations, and the market structure.

A number of authors have attempted to analyze the effectiveness of various policy initiatives designed to affect the level of recycling activity in a given economy. For the purposes of this study, diversion estimates were developed assuming the policy status quo remains in place from 1989 to 2000, i.e. new policy initiatives have not been factored in. In the following analysis of the literature, only the impacts that various policy initiatives would have upon markets for secondary materials, rather than the economy as a whole, were examined.

Attempts have been made to examine the effects of the following types of policies:

- elimination of tax policies favouring primary materials.
- elimination of preferential freight rates for primary materials.
- subsidization of either producers or users of goods containing secondary materials.
- price stabilization schemes.
- recycled content legislation.

Elimination of Unfavourable Tax Policies

Several studies conducted in the 1970's, and Gill and Lahiri in 1980, examined the effects of the United States' favourable tax policies for primary materials on the markets for secondary materials. These policies included the percentage depletion allowances for minerals, oil, and gas, and the special treatment of income for the timber industry.[12] No studies have been made of the effects of tax policies upon the secondary glass and plastics industries. Table 2.6 summarizes the results of these studies.

All the studies concluded that the removal of the subsidies to the mining and forestry industries would not greatly affect the demand for secondary materials and many noted that such significant changes to the tax code would be very difficult to accomplish. In fact, use of secondary materials has increased faster than predicted by any of the studies (U.S. Congress Office of Technology Assessment, 1989, 201). These results are now somewhat dated and so changes in the U.S. tax code and current conditions must be taken into account.

Table 2.6

Estimated Effects of Tax Subsidies on Virgin Materials Prices and of Eliminating Virgin Materials Subsidies on Use of Secondary Materials

Material	Effects on Prices of Virgin Materials		Increase in Secondary Materials Use
	Maximum Possible Effect	Most Likely Impact	
Paper	+4.2%	+1.0%	0.04 - 0.6%
Steel	+3.0%	+2.0%	0.4 - 2.0%
Aluminum	+2.2%	— —	1.0%

Source: U.S. Congress Office of Technology Assessment (1989).

Preferential Freight Rates

In the United States in the mid-to-late 1970's, some groups expressed concerns that primary materials producers obtained preferential freight rates from U.S. railways. Page (ch. 4) describes the efforts by American recycling organizations to force the U.S. Interstate Commerce Commission (ICC) to reverse its allegedly discriminatory rate structure however he was unable to present any estimates of the impact of preferential freight rates on markets for secondary materials. Gill and Lahiri predicted that the elimination of preferential rail freights for primary materials would have little or no effect on the use of recycled materials.

Recycling Subsidies

Anderson (1977), Anderson and Spiegelman (1977) and Gill and Lahiri (1980) all examined the likely effects of the direct subsidization of either secondary materials suppliers or users that was proposed in the United States (H.R. 148 and H.R. 10612). They concluded that such subsidization would be difficult to justify in an economic context unless the social costs of unrecovered scrap materials exceeded existing market values by a factor of several hundred per cent. A significant problem with the proposed subsidies was the fact that they would be paid to users of both pre- and post-consumer secondary materials.

Price Stabilization Schemes

Concerns that large price fluctuations were deterring municipalities from engaging in recycling activities sparked interest in price stabilization schemes for secondary materials. The most commonly suggested methods were the use of buffer stocks and futures exchanges, although long-term contracts (with minimum and/or maximum prices) or buffer funds can have similar effects.

Buffer stocks have been used to dampen price fluctuations in the wastepaper markets in Japan, the Netherlands, and Norway but were rejected in Belgium and the UK (Turner, Grace and Pearce, 1977). Stocks are accumulated in times of low demand and resold in times of high demand. Turner, Grace and Pearce were unable to prove that a hypothetical buffer stock scheme in the United Kingdom would have benefitted municipalities involved in recycling wastepaper. It is also theoretically possible for buffer stock schemes to destabilize income (Butlin, 1977, 226).

Both empirical and theoretical literature have shown futures exchanges can improve the efficiency of commodity markets by allowing commodity users to hedge their purchases and speculators to assume price risk. Anderson and Dower (1978) suggested that futures markets for secondary materials might improve the efficiency of the markets for these commodities. However O'Neill, (1983) using econometric methods and monthly data on inventories and sales in the USA (1962-1980) found that the theoretical efficiency of the market for ferrous scrap was very high. He also noted that the prices of secondary materials which are readily substitutable for the primary materials, e.g. copper, plastic and aluminum, follow those of the primary materials very closely. Thus, these markets were likely to be just as efficient as those for the primary materials.[13]

Butlin (1977) notes that buffer funds (which withhold earnings in buoyant markets and support prices in depressed markets) can destabilize rather than stabilize markets under certain conditions, particularly when the elasticity of supply is unknown (Butlin, 1977, 225).

Recycled Content and Waste Diversion Legislation

The policies discussed above are all directed at affecting the relative prices of secondary materials. Most of the authors cited questioned the effectiveness of any price-oriented policies in affecting the use of secondary materials because of the very low elasticities of supply estimated by their models. However, the supply side of the market has changed so radically in recent years that the validity of their conclusions is now questionable.

Despite the number of states considering its adoption, relatively little research into the effects of recycled content legislation upon markets for secondary materials has appeared. The potential impact of recycled content legislation on the market for old newspaper, and of waste diversion legislation on the markets for a number of secondary materials, are currently being studied by the Research Triangle Institute for the US EPA.

2.4 *References*

1 See notice to waste generators and haulers from Metropolitan Toronto, February 1991.

2 Vertical integration does not necessarily imply the acquisition of one firm by another. It can also be established by contractual relationship with virtually identical efforts.

3 This research was almost entirely inspired by Judge Learned Hand's landmark decision in the Aluminum Company of America (Alcoa) case of 1945. Judge Hand decided that Alcoa's monopoly power in the primary aluminum industry was not restrained by the existence of a competitive secondary aluminum industry. See also Friedman (1967, 278-79), Gaskins (1974), Martin (1982), and Swan (1980).

4. This may currently be the case in the production of canning sheet from UBCs as opposed to primary ingot (Apotheker, 1989,21).

5 An estimate of the own-price elasticity of demand can be derived from the results of the regression anlysis. This elasticity measures the degree to which demand varies in response to changes in the price of the good.

$$e^{D}_{i} = (\Delta Qi/Qi)\ (Pi/\Delta Pi)$$

is the elasticity of demand for good i where Q_i and P_i are the quanitity and price of good i, and Δ denotes the change in price or quantity. If e^{D}_{i} is > 1 then the price elasticity is considered to be elastic and the demand curve is relatively flat. Ife^{D}_{i} is < 1 then the price elasticity is considered to be inelastic and the demand curve is relatively steep

6 $$e^{S}_{i} = (\Delta Qi/Qi)\ (Pj/\Delta Pj)$$

is the elasticity of supply for good i where Q_i and P_i are the quantity and price of good i, and Δ denotes the change in price or quantity. The elasticity of supply can be related to the slope of the supply curve. If e^{S}_{i} is > 1 then the price elasticity is considered to be elastic and the demand curve is relatively flat. If e^{S}_{i}, is < 1 then the price elasticity is considered to be inelastic and the supply curve is relatively steep.

7 The equation:

$$e_{ij} = (\Delta Q_i/Q_i)\ (P_j/\Delta P_j)$$

is the cross elasticity of demand for good i with respect to good j.

8 In the absence of significant variation in the price of woodpulp, Kinkley and Lahiri estimated the coefficient of total consumption of woodpulp in the demand function.

9 The elasticity of substitution between goods i and j is described by the equation:

$$\partial y = \frac{\Delta(Qi/Qj)}{\Delta\,(Pj/Pi)} \cdot \frac{(Pj/Pi)}{(Qi/Qj)}$$

10 For examples, see references in Slade (1981) and Holmes (1988).

11 Holmes cites two studies of materials substitution in American tin-using industries which observed this effect.

12 Below-cost government timber sales and support from the U.S. Department of Agriculture are also important federal subsidies to the lumber industry.

13 O'Neill describes the market for the primary commodity as a "ghost" futures exchange for the secondary commodity.

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3.0 OLD NEWSPAPERS

3.1 Supply

CH_2M Hill estimated that old newspapers (ONP) in 1989 was 17% of the residential waste stream, or 673,200 tonnes. This figure seems high since the Canadian Pulp and Paper Association (CPPA)[1] reports that total shipments of newsprint (including applications outside of newspaper publishing) to users within Ontario was 570,000 tonnes, and imports are an insignificant share of consumption. This figure is lower than peak consumption reported by the CPPA for 1988 of 630,000 tonnes, and consumption has continued to decline in 1990 to 540,000 tonnes. Throughout the newspaper industry, ad linage is down significantly as reported in the annual and quarterly reports of Canada's major daily and weekly publishers which include Torstar Publishing, Thomson Newspapers, and Southam. We have therefore used these industry data in this analysis.

3.1.1 Generation by Sector

Old newsprint (ONP) has been selected as a target material because it is a highly identifiable component of Ontario's residential waste stream and because technology and systems exist to recycle old newsprint. Newspaper was designated as a material for recovery when the blue box program was initiated in Ontario to collect soft drink containers in 1985.[2] Curbside collection of this material through the blue box system has resulted in significant recovery levels, which reached the level of 155,900 tonnes in 1989, according to OMMRI data, or approximately 25% of total consumption.[3]

The focus of this study is on the generation and potential recovery of post-consumer ONP from the residential and ICI sectors. Production overruns, or returns as they are called in the newspaper publishing industry, are not included in this study since they have been recycled in large quantities prior to 1987 and present limited potential for increased recovery.[4]

Current Generation

The majority (70%) or 400,000 tonnes of ONP is generated in the residential sector, according to Metro Toronto waste composition data. Thus, 170,000 tonnes of ONP are generated in the ICI waste stream using the CPPA data.

Projected Generation

Newsprint consumption is expected to show only modest growth as readership is flat and newspapers are experiencing reduced advertising demand due to competition with other media. These factors influence

circulation and newspaper size (number of pages). It is therefore expected that ONP generation in 1992 will be about 550,000 tonnes and perhaps grow slightly to 600,000 tonnes by the year 2000.

For a comprehensive review of ONP generation and factors driving demand, supply and recycling capacity in Ontario and the U.S., see the report titled Ontario's Old Newspaper Supply and Demand in the Context of the North American Market.[5]

3.1.2 Current and Projected Diversion Levels

Current Diversion

Newspapers have been collected in the Blue Box program since 1975. Because of their weight and volume they account for 75% of the materials collected in curbside recycling programs according to OMMRI.

The tonnage of ONP recycled from municipal programs in Ontario in 1989 was 155,900 tonnes, according to OMMRI. The number of curbside households increased from about 1.3 million to over 2 million during 1989. During this time, the average amount of ONP set out for collection remained relatively constant at about 104 kilograms per year per household.

Recovery from the ICI sector is limited, but growing. Several building maintenance firms reported that they have contracted out the collection of recyclables, including ONP. Other locations where ONP is generated have also instituted collection programs (e.g. Harbourfront and the Toronto Transit Commission which reported collection of 7,000 tonnes of ONP through its blue box newspaper recycling program in 1989).[6] When publishers' returns and printroom newsprint waste (i.e. unsold newspapers) of approximately 50,000 tonnes in 1989 are added to the equation, ONP diversion reached an estimated 212,900 tonnes or 37% of newsprint consumption in that year.

Projected Diversion

Since 70% of newspapers are consumed in the residential sector, recovery of ONP is tied directly to the expansion of the blue box program and depots. As recycling becomes entrenched as a way of life for Ontario residents, recovery levels for each household served by blue box programs are expected to rise. Overall collection of ONP is anticipated to level off at about 70% of available supply given the blue box and ICI recovery infrastructure.

In addition, all new Blue Box programs coming on stream in the next decade are expected to include newspapers because of the significant waste diversion potential, and because it is anticipated that markets will strengthen

significantly in the next few years as several ONP de-inking facilities come on stream at paper mills in Ontario, Quebec and the U.S, as discussed later in this chapter.

This should serve as a stimulus to ONP recovery which is expected to increase to 307,800 tonnes in 1992, rising to 390,000 tonnes in 2000 from the residential sector based on continued expansion of the blue box system and increasing recovery rates (see report cited in footnote 5).

Industry is also trying to reduce the volume of ONP generated through returns, but the effects of this are difficult to estimate. However, since recovery systems are in place for this ONP, it is reasonable to assume that it will continue to be diverted from the waste stream. In addition, as source separation systems are put in place in the ICI sector, particularly in office buildings, ONP recovery will increase. We have estimated that the reduction in returns and printroom waste will offset increased ONP recovery in the ICI sector.

Thus, the total recovered quantity of ONP in Ontario is expected to reach 364,800 tonnes by the end of 1992, and level off at 447,000 tonnes by 2000, as shown in Table 3.1.

Table 3.1

Old Newsprint Generation and Diversion Estimates (tonnes/year)

	1989	1992	2000
Residential Generation	400,000	385,000	420,000
Residential Diversion	155,900	307,800	390,000
ICI Generation	170,000	165,000	180,000
ICI Diversion	57,000	57,000	57,000

3.1.3 Potential for Increased 3R's Activity

Reduction

Industry efforts to reduce the weight of newspapers over the next decade as a means of waste diversion will produce slow but steady results. It is expected that there will be a 6.4% reduction in newsprint weight by 2000, representing a reduction in the average sheet from 48.1 to 45 grams per square metre.[7] This could result in a total diversion in 2000 of 38,400 tonnes based on projected consumption.

The publishing industry is expected to begin using lighter weight newsprint, resulting in a measurable diversion by 2000. There is opportunity to increase this waste reduction significantly if the switch to lighter materials occurs sooner. The Canadian Pulp and Paper Association believes that newsprint downweighting by 11% (instead of 6.4%) is possible, but will require industry willingness and action to achieve.

Recycling

Increased recycling of this material by the ICI sector is possible but unlikely during the study period. ONP is generated in small volumes by individual businesses, and thus would be an unlikely target for recycling programs.

3.2 *Demand*

3.2.1 Market Structure

North American Market

Old newsprint is traded on a global market, and Canada is a small player in terms of the ONP it purchases and generates compared its role as a newsprint exporter. Canada ranks 13th amongst the 15 countries that purchase waste paper, consuming 3% of the total amount traded.[8] The world ONP market is volatile, fluctuating in response to changes in the world economy, labour disruptions, and shipping costs. All of these conditions affect the Ontario market.

It is anticipated that the structure of the newsprint market in North America will undergo significant changes over the next five years. These changes will have an effect on the supply and demand of old newsprint and will re-define the relationships between consumers and producers.

In 1990 there were eight newsprint mills in North America which de-ink old newsprint; one of these is in Canada, located in Thorold, Ontario. At the present time, these mills are not able to consume the vast North American supply of old newsprint which is being generated through curbside collection and other waste diversion programs. The reason for this gap is, in part, due to the level of mill technology. Most paper mills were designed to use virgin wood fibre exclusively in the manufacturing process, and significant capital investments, generally in the order of $80 to $100 million are required to retrofit current mills with de-inking capacity. In addition, most Ontario paper mills are typically located in remote, northern areas close to the primary resource and far from the supply of old newsprint stock.

Demand for old newsprint is being stimulated by evolving market forces. Increasing demand from consumers and governments for recycled-content newsprint has caused the industry to expand de-inking capacity. Firms which have traditionally been exclusive users of virgin pulp are now planning to build new de-inking capacity in order to compete in the future market. For remote mills retrofitted with de-inking capacity, the delivery of old newsprint is not immediately cost-effective under current market conditions. However, mill owners appear to believe that the potential long-term payoff of recycled-content newsprint market share, lower fibre costs and less negative press regarding environmental issues justify current levels of investment.[9] Factors influencing the demand for ONP are discussed further in Section 3.2.2.

The planned increases in de-inking capacity are substantial and, when fully operational, will be capable of eliminating some of the current glut of old newsprint in North America. Indeed, the newsprint industry as a whole is concerned that future demand for old newsprint may greatly exceed supply and Ontario is expected to become a net importer of ONP. In response to this situation, it is anticipated that collection of ONP in Ontario will level out at about 400,000 tonnes by 2000.

Until recently, long-term agreements with suppliers were not common in the newsprint industry. These relationships are changing as mills are forming long-term agreements with recycled material collectors and processors in order to guarantee a steady supply of fibre. Canadian Pacific Forest Products, for example, has signed a long-term contract with Laidlaw Waste Systems for the delivery of old newsprint and magazines to two Canadian Pacific Forest Products (CPFP) mills in Canada, one of which is located in Thunder Bay, Ontario.[10] A similar arrangement has been struck between Weyerhaeuser Paper Co. and Browning Ferris Industries (BFI), which recently purchased a Texas processor.[11] The BFI-owned processing company is contracted to supply secondary fibre to Weyerhaeuser. In addition, Quebec and Ontario Paper acquired CFI, (now called Quebec and Ontario Fibre), a Toronto fibre processor, in order to secure old newsprint supplies predominantly in the Ontario market.[12]

Ontario Market

In 1990, Ontario recycling programs are expected to recover approximately 209,300 tonnes of old newsprint.[13] This old newsprint is sold to a variety of end-markets including both local and export (e.g. off the continent).[14] This makes Ontario a net exporter of old newsprint. This is a very new situation for the province, since it has traditionally been a net importer of ONP, buying approximately 50,000 tonnes annually from the U.S.[15]

The majority of recovered ONP is sold to Quebec and Ontario Paper (Q&O), Ontario's first de-inking mill, located in Thorold, Ontario. This is an integrated mill, capable of producing de-inked pulp and manufacturing newsprint. Q&O Paper obtains most of its old newsprint from Ontario municipalities The contract between Metropolitan Toronto and Quebec & Ontario Recycling gives the latter exclusive access to Metro ONP supplies for $28 per tonne until 1994.[16] In 1989, this generated just over $1 million in revenues for Metropolitan Toronto. Many other municipalities deliver old newsprint loose directly to Quebec and Ontario Paper's mill for de-inking.

In the summer and fall of 1990, Quebec and Ontario Paper was strikebound and did not accept shipments of ONP from curbside programs. During this strike period, most old newsprint normally purchased by the mill was sold to other sources including Indonesia and India. The Pacific rim has traditionally been an importer of ONP from North America because these countries are short in fibre and newsprint consumption is growing. These markets are expected to continue to compete for ONP fibre generated in North America. In addition, a small amount of old newsprint recovered in Ontario is sold to local end-markets for manufacturing molded pulp products and linerboard.

Government initiatives have been driving demand for recycled content in newsprint, particularly in the U.S. In several U.S. states, legislated and voluntary agreements are in place with publishers who are expected to put pressure on publishers to supply recycled content newspaper. These initiatives suggest that recycled content levels will settle out at the 40% level on average, although some publishers may use 100% recycled content newsprint. The newsprint industry has responded to these demands. Plans for several new de-inking facilities have been announced which could result in a fibre demand that exceeds the available supply in the province. Companies planning to install de-inking capacity in Ontario and Quebec which sell most of their newsprint to U.S. publishers are as follows:

- Atlantic Packaging of Whitby, Ontario began operation in early 1991. The facility will initially operate at 100,000 tonnes/year, producing 100% recycled fibre newsprint, and consuming approximately 105,000 tonnes/year of old newsprint. A total of 160,000 tonnes/year of old newsprint will be required in three years when the mill is expected to be operating at full capacity, producing 150,000 tonnes per year.[17]

- Canadian Pacific Forest Products (CPFP) will be adding de-inking facilities to their existing mills in Thunder Bay, Ontario and Gatineau, Quebec. Construction is expected to be completed by mid-1991, with an expected production output of 265,000 tonnes/year in Thunder Bay and 485,000 tonnes/ year in Gatineau. Demand for old newsprint is projected to be 95,000 tonnes/ year and 175,000 tonnes/year respectively.[18]

CPFP has formed a long-term agreement with Laidlaw in order to ensure that adequate ONP supplies are made available to satisfy the demands of these two mills. CPFP had previously sourced the ONP supplies required by their mills from a number of short-term agreements which proved difficult to ensure adequacy of supply.

Laidlaw's Burlington, Ontario operation will be responsible for sourcing all materials for these two mills. It is expected that a portion of this material will be sourced via Laidlaw's existing curbside collection contracts in the U.S. and Canada. The balance will likely be acquired by Laidlaw through brokers.[19] Laidlaw Waste Systems and Canadian Pacific Forest Products are both owned by Canadian Pacific Limited.

Laidlaw/Canadian Pacific Forest Products has indicated that it has secured the necessary contracts for ONP supply. Suppliers are currently signing 10 year fixed price contracts. Most of the necessary old newsprint is from programs in the northeastern U.S.[20]

- Abitibi-Price Inc. has announced the construction of an ONP de-inking facility at its Thunder Bay newsprint mill requiring 120,000 tonnes of ONP by 1993. With the addition of this facility, 40% of the company's yearly output will include recycled fibre.[21]

In addition, several new plants in Quebec and the U.S. are expected to impact on the Ontario situation.

- Diashowa Forest Products Ltd. of Quebec City, PQ, will add de-inking capacity to its newsprint and telephone directory paper mill. The mill will process 120,000 tonnes/year of old newsprint and magazines. Old newsprint will be sourced from Canada and the north-eastern U.S. Secondary fibre will account for 20% of the mill's feedstock.[22] It is unlikely that this mill will accept old telephone books.

- Jefferson Smurfit Newsprint has recently announced its intentions to site a new de-inking mill in upper New York State, in order to target ONP supplies from the 'urban forest' in the cities of the northeast states, which will increase competition for ONP in this region. The mill will consume 305,000 tonnes of ONP and other waste paper per year and will produce about 254,000 tonnes of newsprint.[23]

- Cascades Inc. of Quebec is planning a joint venture with the Steinbeis Group of West Germany to build a de-inking plant to

manufacture office paper from old newsprint and other paper products. Production output is projected to be 60,000-100,000 tonnes/year of recycled office paper with at least 50% post-consumer product made up of 50% old newsprint. Sites being considered include: Niagara Falls, NY, and East Angus, Montreal, and Trois Rivieres, PQ.[24]

- Stone Container - Consolidated Bathurst is conducting a feasibility study to locate a de-ink facility in Quebec. The firm has indicated to its customers that they will be able to provide recycled newsprint by the end of 1991. The supply of old newsprint is likely to be sourced from the U.S. because of a widespread assumption that Canadian old newsprint supplies will be consumed by local plants.[25]

These established and planned mills in Ontario will require a combined total of over 500,000 tonnes of old newsprint per year by the end of 1992. Although local sources are likely to be targeted, there is no guarantee that Ontario supplies will be completely utilized, since there are no import barriers other than the cost of transportation. Nevertheless, this projected increase in de-inking capacity is expected to have an effect on the demand for local old newsprint as well as other secondary fibres.

In addition to the de-inked market, approximately 17,000 tonnes/year of Ontario old newsprint will be required by local non-de-ink markets for the manufacture of various types of paper board, construction products, and molded pulp products. A more detailed list of end products includes, but is not limited to:

- folding cartons
- industrial grade sanitary tissue
- paper liner for gypsum wall board
- egg cartons, plant peat pots, meat trays
- packing material
- insulation
- animal bedding
- roofing materials - i.e. paper and shingles

Existing firms which use small quantities of old newsprint for non-de-ink purposes include:

- Vedyol Mulch of Canada Ltd. purchases an annual volume of 210 tonnes of old newsprint for the manufacture of molded pulp products. Substitution of other materials for old newsprint has never been considered.[26]

- Paperboard Industries purchase an 5,000 tonnes annually of old newsprint for manufacture of top and bottom liner paper for

corrugated, boxboard and chipboard containers. Materials originate in Ontario and Quebec. This mill only purchases secondary material, due to the higher costs of primary fibre. Expansion of current capacity is not planned.[27]

- Beaverwood Fibre, of Thorold, Ontario purchases approximately 9,000 tonnes of old newsprint per year for the manufacture of paper liner for gypsum drywall. All old newsprint originates in Canada and is sourced through Ontario fibre brokers. Material specifications require no hotmelt glues in the delivered product, thus the company does not accept articles like magazines and telephone books. Currently, the price paid for old newsprint is $23 per tonne delivered by the vendor to the mill's door[28], compared with the Ontario listed price if the mill provides its own transportation of $5-10 for de-ink news, and $0-5 for repacked (board mill) news.[29]

  Beaverwood Fibre is capable of processing other grades of paper including mixed and office paper as well as boxboard, making material substitution a possibility if old newsprint becomes prohibitively expensive or in short supply. The resultant difference in production costs if this substitution was to occur is not known to RIS, nor are comparable costs for using virgin fibre. However, these other grades are not considered as useful or as "clean" as old newsprint, thus Beaverwood would likely only be interested in using them if they were available at very low or negative prices, i.e. municipalities had to pay to have ONP taken away.[30] Other smaller users of ONP in Ontario include Strathcona Paper in Napanee and Sonoco.

The generation, recovery and end-uses of old newspaper in Ontario is profiled in Figure 3.1.

3.2.2 Factors That Influence Demand

Factors influencing demand for old newsprint have changed significantly since curbside collection programs became widespread in Canada and the United States resulting in supply running ahead of demand and the paper industry's capacity to recycle ONP. The Canadian paper industry was slow to respond to the demand for recycled content since they had experienced this fad during the 1970's, only to see the bottom drop out of the market.

Moreover, the capital intensity of the industry requires a significant level of investment for de-inking which is difficult to justify when the industry is in an overcapacity situation as the result of major investments initiated after the 1982 recession. Overall newsprint demand has softened significantly

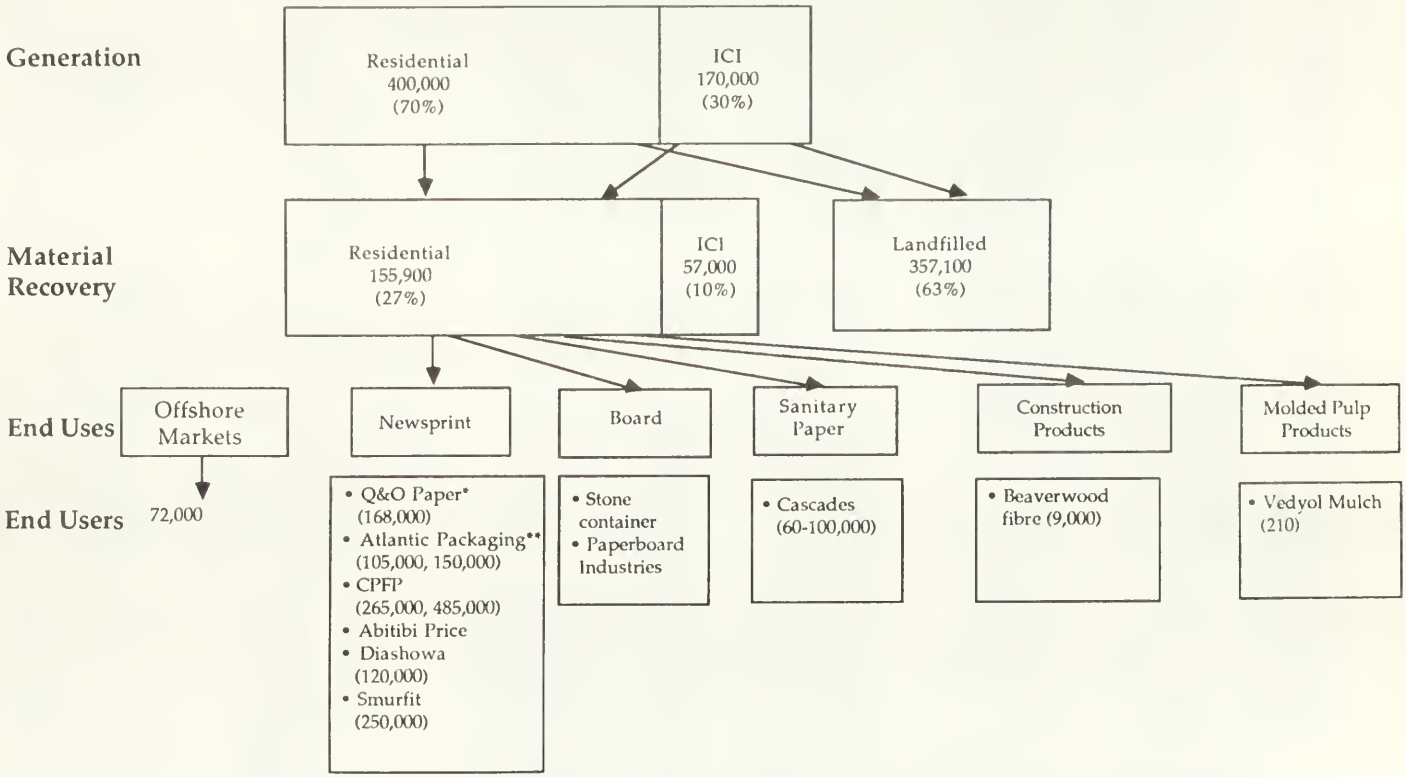
throughout North America as demonstrated by the consumption statistics, and the has resulted in falling revenues which have been compounded by a high Canadian dollar and interest rates. As a result, Canadian paper companies have weak balance sheets and are in a difficult position to justify additional investments. Nonetheless, most companies have recognized that if they are to retain their clients and market share, particularly in the important U.S. market, they will have to supply them with recycled content newsprint. As a result, demand for ONP is expected to increase dramatically in the 1990's as de-ink investments come onstream in Ontario and elsewhere in North America. This is forcing the paper companies to make arrangements for secure supplies of ONP to feed these facilities.

The market began to experience a glut of ONP beginning in 1988, which continued through 1989 and 1990. However, the prospect of several de-inking facilities is expected to have a major impact on the dynamics of supply and demand, and ultimately price for this commodity in Ontario. Historically, Ontario users of ONP were able to secure high volume, relatively uncontaminated supplies of ONP directly from municipal programs. This however, is changing as demand for ONP is projected to exceed supply by the end of 1992. These factors underlie the paper manufacturing industry's move to contract to secure long term supply of ONP at set prices. Thus, most municipalities in Ontario should be able to secure markets for their ONP.

The additional benefit of the increase in de-inking capacity in Ontario, Quebec and the northeast U.S., is that prices can be expected to increase, after having bottomed out during the peak of the glut in the summer of 1990. Demand for ONP is expected to strengthen because paper companies must meet the demands of their customers for recycled content newsprint, or risk lowing market share.

Export markets for North American ONP are expected to continue to be strong, particularly in countries which are short of virgin fibre. North American newsprint is particularly valued because of its high content of virgin fibre. This will increase the pressure on prices as overall demand for ONP increases. This will have some downside spillover effects on other users of ONP such as boxboard and corrugated manufacturers who will likely find the ONP fibre prices too high in terms of their overall production costs, as discussed in sections 5 and 6 of this study.

Figure 3.1
ONP (tonnes per year)
Ontario 1989



* Chicago Tribune
**Various advertisers and newspaper publishers

3.2.3 Factors That Influence the Choice Between Secondary and Primary Material

The choice between old newsprint and virgin pulp is currently affected by a combination of economics, customer demand for recycled fibre content, which in turn is being driven by government legislation and other initiatives to stimulate demand. For the paper mills, the economics of using recycled ONP vary because of the cost of transportation from large urban markets where ONP is generated in quantity. If a mill can transport old newsprint to its door inexpensively, the end product can be produced for much less than its virgin fibre competitor. Abitibi Price reports that virgin pulp is priced between $12 and $67 per tonne higher than secondary pulp.[31] The key to inexpensive transportation is access to shipping or rail routes, often on a back-haul basis.

This transportation cost factor favours mills located in the U.S., over those located close to the forests of northern Ontario. As prices for ONP rise, this will further disadvantage Ontario mills, and, combined with the forecast that demand for ONP will exceed available supply within Ontario, is likely to limit future investments in ONP de-inking capacity.

The cost of producing pulp is also related to the size of the mill. Economies of scale exist as the cost per tonne of producing pulp in large de-ink mills is less than that for a relatively smaller operation. This is because the difference in capital costs required to establish mills are not proportionate to the size of the capacity installed. Table 3.2 shows the variance in pulp production costs for three different sizes of new mills and illustrates the savings realized by larger mills. Estimates assume a delivered cost (i.e. including transportation) of $35 per tonne for old newsprint.

Table 3.2

Mill Size vs Pulp Production Costs For De-Inking Mills

Size of Mill (tonnes/day)	Pulp Production Costs ($/tonne)	Tonnes/Year	Cost/Year
600	$157	218,400	$34,288,800
400	$171	145,600	$24,897,600
200	$212	72,800	$15,433,600

Source: Abitibi Price

Abitibi Price reports that under 1990 market conditions, de-inked pulp is less expensive to produce than virgin pulp as long as the cost of old newsprint remains less than $43 per tonne including delivery to the mill. If the fibre cost exceeds this threshold (e.g. because of transportation costs or market price increases), it becomes more economical to use virgin feedstock (these estimates are based on production economics for a 400 tonne per day mill in the U.S.)[32]

Another issue for many mills, such as Canadian Pacific Forest Products, is the difficulty in finding harvestable timber at a price which is economical for their individual circumstances. Available supplies of appropriate species are dwindling, and are becoming more difficult and costly to access.

Increasing recycling activity will result in a significant reduction in the use of virgin fibre for newsprint and other fibre grade production, and associated savings in water, cost of bleaching and other chemicals, and energy usage overall. However, industry rule-of-thumb suggests that fibres can only be reused an average of five times before they degrade and become part of pulp and paper sludge. It is estimated that 20% of recycled fibres used in each recycling process are washed away in the sludge. This means that the input of virgin fibre will still be required in total newsprint production, and thus paper companies will produce newsprint with a range of recycled fibre content from 0% to 100% depending on individual mill economics and market requirements.

Beyond production economics, the choice between virgin and secondary fibres is being driven by consumer demand, impending legislation, and dwindling forest resources. Legislation has been passed in several jurisdictions including California, Connecticut, Florida, Maryland, and South Dakota, establishing requirements for newspaper publishers to use recycled content paper. The legislation in most of these states generally recognizes the limited capacity of the newsprint industry to supply recycled content newspaper, and thus phases in the proportion of secondary fibre in the newsprint sheet over the decade. In an attempt to meet impending legislation, or comply with existing laws, paper manufacturers are expanding their product lines to include post-consumer recycled content newsprint. There is also a move to retain market share as demand for virgin end products wanes.

There is still some debate as to whether the use of recycled content paper creates production issues for the publishing industry. The Canadian Pulp and Paper Association has indicated that the quality of print, and ability to run effectively on the printing press are no longer concerns when recycled content paper is being used. This association also stated that the publishing industry is still somewhat hesitant to use recycled content paper because of its

brightness for colour printing and runnability which results in web breaks on high speed presses if recycled content newspaper is not as strong as virgin news. However, a recent survey of publishers in the United States who were using recycled content newsprint indicated that quality has improved and that these factors are generally not an issue. Some firms, such as Southeast Paper in Georgia have invested in technology to make the quality of the sheet virtually equivalent to virgin content newsprint, with a 95% recycled fibre content.[33]

3.2.4 Price/Elasticity Analysis

The purpose of the discussion that follows is to lend some insight into the potential consequences of alternative government strategies to encourage the re-use and discourage the disposal of old newspaper (ONP). Here changes in both the demand for and supply of ONP are focused upon, with an emphasis on the major product manufactured from ONP in Ontario, old newsprint pulp (ONPP).

Elasticity of Demand Issues

Ontario consumption of ONP, as shown in Table 3.3, has risen significantly (if not steadily) since 1980. The large increase has been due to expanded use of ONPP de-inked in the manufacture of newsprint.

Lately prices for ONP have been very low. A recent strike at Q & O and the large increase in Southern Ontario ONP supply due to enhanced recovery efforts have combined to produce an ONP price to generators at times not far from $0. However, over the past decade, prices have generally been much stronger. As Table 3.3 shows the average July price was about $45 throughout the 1984-1989 period. In large part this reflected the policy of Q & O, which was to enter into long term contracts for local ONP to assure a significant portion of its requirements, at a price which averaged in the neighbourhood of $60 throughout this period. The remainder of Q & O's fibre requirements were made up by imports which could usually be obtained at a spot market price lower than this (though with longer transport routes).

Section 3.2.1 described how the demand for ONP is likely to increase significantly due to the major expansions planned for Ontario, Quebec and the northeastern United States. Other things equal, an increase of this magnitude should result in a much stronger market for ONP, and should reflect a manufacturer's willingness to pay prices at least as high as those in the past.

However, the indicators do not run unambiguously in the direction of increased willingness to pay. The de-inking capacity expansion reflects, at least in part, the manufacturers' perception that increased supplies of ONP will be available from enhanced ONP recovery programs across North

America. In addition, unexpected softening in the market price for newsprint (from supply over expansion and decreased demand for newsprint) limit the price the de-inker's are willing to pay.

The size of the recent changes in both the demand and the supply of ONP make it impossible to predict market consequences. Nonetheless, it is useful to consider the factors working to strengthen and those which may act to weaken the demand for Ontario-generated ONP. These include the character of the final market for newsprint with ONP content, the nature and degree of increased U.S. recovery of ONP, and the strategies pursued by Ontario secondary market players:

- The demand for newsprint. The demand and supply balance in the overall market for newsprint will set the overlaying price parameter within which the de-inkers' demand for ONP will operate. Only serious downward pressures on demand for North American produced newsprint (recession, declines in readership, availability of lower costs offshore sources), or over expansion of North American supply will weaken newsprint prices to the extent that de-inkers willingness to pay for ONP would be affected.

- The demand for newsprint with secondary fibre content. In the past there was no distinct market for newsprint with secondary fibre content. The product's market niche was primarily determined by its quality and price performance compared with the virgin fibre competition. Lately this has changed. There is now a distinct and rapidly increasing demand for newsprint with recycled content. This market appears to be growing with publishers' desires to display environmental consciousness and direct public/regulatory pressure on newspapers to cut down on their product's contribution to landfilled waste. To the extent that this raises the market share and price of recycled newsprint, the maximum price which de-inkers are willing to pay for ONP will also increase.

  Regulatory requirements for a minimum recycled content are playing an important role in confirming and accelerating this trend.

- The demand for newsprint with locally recovered secondary fibre. As indicated above, most of Canada's newsprint production is exported, primarily to the U.S. This output mostly ends up in American cities' waste streams. The pressure on U.S. newspapers to increase recycled content reflects, at least in part, the concern with U.S. waste disposal problems. To the degree that the demands for recycled fibre are narrowed to that originating in more local sources of supply, the demand for Ontario-generated ONP by Ontario producers exporting to the U.S. will be modulated.

- The availability of cheap alternative sources. Ontario sources of ONP have the advantage of being relatively close to the large existing and projected tonnages of de-inking capacity identified in Section 3.2.1. However, with recovery efforts increasing in the U.S., the supply of ONP will expand, especially in the large urban centres with landfill capacity problems and high costs of disposal. Additionally, the availability of backhauls from U.S. newsprint manufacturers can help offset their transportation costs disadvantage. However, despite this combination of factors, demand for Ontario generated ONP is expected to be strong given the overall gap between supply and demand.

- The competitiveness of demand for ONP. The extent to which an increased market for recycled newsprint is translated into higher prices for ONP depends not just on the supply and demand balance, but on the competitiveness of market demand for ONP. Increased profitability in the ONP de-inking business and higher prices for recycled newsprint may produce a higher price for suppliers of ONP. This would of course be welcome to municipalities facing an increasing bill for collection and transportation of source-separated ONP.

  However, this may well not occur. If the market channels for ONP generators are limited, an increase in the maximum de-inkers are willing to pay may not result in much of an increase in the price actually paid. The greater the degree of vertical integration described in Section 3.2.1, with de-inkers controlling supply sources, the more difficult will municipalities and other ONP sources find it to obtain a share of the increased revenue.

Elasticity of Supply Issues

In some respects, municipalities behave like "firms", "producing" ONP by diverting it from their solid waste streams. While ONP has a value in the market for secondary fibres, the price of ONP has only had a small influence on the willingness of municipalities to supply the market. The "price" driving the municipal production of ONP is that associated with landfill. In effect, municipalities are willing to incur costs related to collecting, sorting and warehousing ONP up to the equivalent cost of landfill. Thus, as the long run marginal costs (LRMC) of landfill rises, the potential supply of ONP from municipalities increases. Importantly, this relationship is largely independent of the market price for ONP. Clearly, the effective market price of ONP can be negative, with little or not effect on quantities supplied to the market.

This phenomenon is illustrated in Table 3.3. (Table 3.3 shows market prices and actual quantities consumed. The information cannot be used to derive implied demand or supply curves). While consumption of newspaper grade secondary material has risen considerably, especially since 1986, prices paid to suppliers have dropped. Prices paid for baled, unsorted newspaper (ONP from municipal collection programs are generally regarded as being of lower quality than newspaper from other sources. Foreign objects, dirt, excess magazine content and high moisture content are typical.[34]) delivered to dealers remained constant in nominal terms from 1984 to 1988. This means that in real terms, prices were falling over this period; a precipitous drop in prices paid was occasioned when the blue box program was widely introduced. Currently, prices for unsorted ONP are in the zero to $5.00 per tonne range; sorted ONP garners a maximum price of $7.50 tonne.[35]

Table 3.3

Ontario Market for ONP (and similar wastepaper grades) 1980-1989

Year	Price1 ($'89/t)	Tonnes (;000)	Growth (%yr/yr)	Year	Price1 ($'89/t)	Tonnes (;000)	Growth (%yr/yr)
1980	n.a.	107.0	—	1985	48.97	159.9	(2.1)
1981	78.90	112.1	4.8	1986	47.04	158.5	(0.9)
1982	56.37	125.1	11.6	1987	45.07	192.3	21.3
1983	53.15	160.0	27.9	1988	43.31	234.1	21.7
1984	50.52	163.4	2.1	1989	12.50	n.a.	n.a.

Notes: 1 Average July prices paid in Toronto for unsorted news (baled, f.o.b. dealer gate).
Source: OFIA 1989, *Recoup*.

As noted above, the LRMC of landfill is probably the best indicator of potential variations in the supply of ONP. As the LRMC of landfill rises over time, municipalities should be increasingly willing to accept lower prices for ONP, even to the point of paying up to the LRMC of landfill to have ONP hauled away. (If the annual "production" of ONP by a municipality is X tonnes, then at the LRMC of landfill, the "supply" of ONP for a given period is infinitely elastic at the quantity represented by X). If ONP is banned from landfill, this connection no longer exists. In this event, the cost of alternative disposal would influence quantities supplied. Should there be no legal alternative method of disposal, municipalities would be placed in a situation where prices (in practice, costs) could be dictated by ONP consumers and/or ONP dealers.

3.3 *Assessment of Market Capacity to Absorb Supply*

Ontario is a net exporter of ONP in 1990, primarily because of the excess of supply generated by curbside collection programs. However, once anticipated de-inking mills become operational, this situation will change, and Ontario will not be able to satisfy all provincial de-inking demand by domestic collection of ONP which is expected to reach about 70% of available supply. Most mills will need to import ONP from the U.S, where there is an abundant supply of ONP, and the supply will exceed demand for an additional year or two, until de-inking capacity catches up with supply.

In addition, the transportation economics favour Ontario mills sourcing as much ONP as possible from the Ontario market. This means a strong and healthy market for the recycling of ONP in Ontario.

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4.0 *FINE PAPER*

4.1 *Supply*

4.1.1 Generation by Sector

The Institute of Scrap Recycling Industries (ISRI) has a definition for fine paper, called "office mix" which consists of white and coloured ledger, and computer print-out. For purposes of this study, we have used this definition to capture this as fine paper.

Current Generation

Fine paper is generated in large quantity by Ontario households and businesses. According to the Canadian Pulp and Paper Association (CPPA), the amount of fine paper consumed in Ontario in 1989 was 434,000 tonnes, which would include paper in the office mix category as well as other high grade printing and writing papers..

CH2M Hill estimates that 1.83% of the residential waste stream (4,053,200 tonnes) is fine paper, for a total of 74,000 tonnes/year. Generation in the ICI sector was calculated as the difference between provincial generation and household generation, approximately 360,000 tonnes per year.

Projected Generation

Based on consumption of this grade of paper staying at the same per household rate, generation of waste fine paper is a function of household growth. Thus, in 1992 it is estimated that waste fine paper in the residential sector will be 77,465 tonnes and in 2000 will rise to 84,210 tonnes. The corresponding figures, developed assuming that the ICI sector retains its share of the overall fine paper stream are 375,630 tonnes in 1992 and 408,370 tonnes for 2000.

4.1.2 Current and Potential Diversion Levels

Current Diversion

Recovery of fine paper from Ontario businesses consists of a growing number of office paper recycling programs operated by companies such as paper brokers, waste haulers, and confidential paper collection companies. Collection programs are based in large office towers, which, for the most part, are located in urban centres. Comparatively few small complexes and buildings are serviced. Based on surveys of the fine paper collection companies, RIS estimates that collections in the province recover in the order of 30,000 tonnes of fine paper per year.

Fine paper is not included in residential recycling programs in Ontario with two exceptions: Guelph and Trenton, although it is being collected through curbside programs in several U.S. states.[1]

Projected Diversion

Reduction

Over the next ten years, the amount of office fine paper, as a percent of the provincial waste stream, will be reduced. As part of this transition, there will likely be a shift in the utilization of various grades of papers (e.g. CPO, fine writing, photocopier etc.). For instance, the current trend toward greater utilization of recycled content paper, which is usually considered coloured ledger, will result in a reduction of white ledger. As well, certain recycled content writing papers presently on the market are manufactured from groundwood fibres instead of the traditional softwood pulp furnish, and are not recycled back into fine paper. The continued use of these products will likely create a reduction in the volume of recyclable fine paper available in the waste stream, and may present a barrier to fine paper programs, because these fibres are not easily distinguishable from higher grade fine papers.

With a greater usage of electronic mail and double-sided printing and photocopying, it is anticipated that by 1992, there will be a 10% in reduction in ICI generated fine paper and a 30% reduction in 2000, or 53,300 and 173,800 tonnes respectively.

This is incremental to the 30,000 tonnes currently diverted. The July 1991 ban on landfilling of ICI fine paper in Metro Toronto is also expected to encourage reduction and recycling although these effects have not been quantified. Total diversion in the ICI sector is estimated to be 83,300 tonnes by 1992 and 203,800 by 2000.

Recycling

Because there are no announced intentions to collect fine paper through residential programs, no appreciable diversion of fine paper generated in this sector is anticipated under policies in place as of 1990. However, it can be expected that this material will be collected if the province's waste diversion goals are to be met.

To indicate the order of magnitude of material that this would generate, we have assumed that 25% of the residential fine paper waste stream would be collected by 1992, or 19,365 tonnes and 50% by 2000 or 42,100 tonnes. Together with fine paper diverted from the ICI sector, the total diversion would be about 102,665 tonnes in 1992 and 245,900 tonnes in 2000. Table 4.1 summarizes current and projected generation and diversion rates for fine paper.

Table 4.1
Fine Paper Generation and Diversion Estimates in Ontario
(tonnes/year)

	1989	1992	2000
Residential Generation	74,000	77,465	84,210
Residential Diversion	nil	19,365	42,100
ICI Generation	360,000	375,630	408,370
ICI Diversion	30,000	83,300	203,800

4.1.3 Potential for Increased 3R's Activity

As described, there is enormous potential for reduction of fine paper in the commercial waste stream as a result of increased dependance on electronic mail in communications. In addition, many firms are initiating policies requiring employees to use double-sided copying where possible, in order to further reduce waste.

In the residential sector, reduction opportunities consist of decreasing the volume of junk mail delivered to households in the province.

4.2 *Demand*

4.2.1 Market Structure

Like ONP, secondary fine paper is traded on a global market. It is a high value material and can be economically shipped to markets throughout the world. The major destination for this fibre is sanitary tissue mills.

Besides sanitary paper, post-consumer fine grades are utilized in the production of fine paper. Laser printed fine paper is a particular problem since it cannot be de-inked sufficiently with current technology to be used in fine papers and so it is used in products which do not require de-inking such as paperboard, construction material and molded pulp. It is difficult to estimate actual usage by each of these industries as many firms in the Ontario market make several different grades of product. The result is that information on utilization by individual mills is not available.

Post-consumer fine paper is collected from industrial and commercial sector generators via office paper collection programs. The majority of domestic fibre used in manufacturing processes is recovered from pre-consumer sources such as printers and converters. A small portion originates from post-consumer generators such as office towers. Recovered paper is processed, either by the collector, or by an independent firm, and brokered directly to mills, either as office mix or as specific fibre grades such as white

ledger, coloured ledger etc. These fibres are used for feedstock in manufacturing various products, as follows:

- sanitary paper
- recycled content fine paper
- shingles, and roofing paper
- paper liner for drywall
- linerboard for use in corrugated cardboard
- boxboard
- molded pulp such as fibre flower pots and egg cartons
- insulation

Of the fine grade fibre utilized each year in the province, a small portion is recovered from domestic sources, and the remainder is imported, mainly from the U.S. [2] The majority of high grades are purchased for sanitary paper, and paperboard.[3] A growing percentage is being used to manufacture fine writing and printing paper. The remainder is utilized in molded pulp mills.[4] In addition, the CPPA has provided information which indicates that 110,000 tonnes of high grade fine paper was consumed by Ontario paper mills in 1990; 84,000 tonnes came from outside Ontario.[5] For the most part, this material is retrieved from commercial printing operations as trimmings and cuttings, and are using all available domestic supply from this source.

Sanitary paper mills have been using secondary fibre for many years, however it has become fashionable to advertise this fact to customers only recently.[6] These mills manufacture a range of products from toilet tissue aimed at the consumer or industrial user to napkins and paper towel. Typically, the recycled paper is blended with virgin fibre, with the exception of a few mills that make 100% recycled content products, such as Atlantic Packaging in Scarborough Industrial products usually have less stringent requirements for whiteness, softness and brightness, and can be made from a higher percentage of recycled fibre which is either de-inked, bleached or simply washed, depending on the mill. Alternatively, consumer grocery store products typically use higher concentrations of virgin pulp to achieve specific "appearance" requirements. Overall, North American tissue products contain an average of 28% recycled fibres.[7]

Sanitary paper mills utilizing secondary fine paper include:

- The Fort Howard Paper Company, of Wisconsin and Georgia. This firm is a major sanitary paper products manufacturer in the U.S. Its mills have been set up to accept "office mix" paper (e.g. a mix of the various fine grades described) instead of the various separated grades required by most other North American mills. The firm made the decision to develop their process to use a mixed grade in because it is a less expensive feedstock than ledger and high grade papers. In late 1990, office mix traded at –$10 per tonne in Toronto,

compared with per tonne prices of $140, $110-115, and $145-155 for white and coloured ledger and computer print-out. Although specific information on quantities of materials purchased by this firm are not available, waste collectors have indicated that this firm purchases large quantities of Ontario fine grade fibres through brokers.[8]

- Cascades Inc., of Quebec. This firm reports purchasing a yearly total of 7,200 tonnes of fine paper, divided equally between white coloured and "office mix" grades. The materials are distributed between five mills in Ontario and Quebec, and are used in the manufacture of all products listed in this section.[9]

  This firm produces a 100% recycled industrial grade towelling and tissue, marketed by Wyant & Company Ltd., and corrugated containers. A company broker reports that the material specifications followed are a modification of American Paper Stock Standards which outlines specifications for various grades of paper. In addition, Cascades' mills cannot tolerate laser printed paper.[10]

- Perkins Paper Ltd. of Quebec. This firm reports purchasing a yearly total of 35,000 tonnes of ledger grades from post-consumer sources. The materials are used to make "Budget", "Decor", "Perkin's", "Balpex", "Purspun", "G.H. Wood" and "Kesply" consumer and industrial bathroom tissue and table napkins. All fibres are purchased through various brokers. Within the next year, Perkins Paper will expand its paper stock capacity by 30-40,000 tonnes per year.[11]

- Atlantic Packaging Products Ltd., of Scarborough. This mill does not currently purchase any post-consumer office paper grades, but has been included in this discussion as a potential market because at one time this mill purchased white ledger paper to manufacture "Atlantic" paper towels and "April Soft" toilet tissue, as well as other towels sold under a private label. The mill uses a washing system instead of de-inking machine to clean fibres before they are used as feedstock. As a result, ink on xerox, laser and fax paper is difficult to remove, and the mill has had to discontinue purchasing all office grades for fear of contamination. Thus, current products do not include industrial or "recycled content" towelling. However, company officials feel that the start-up of the new Whitby de-inking facility described in Section 3.1 may alter the range of materials that can be accepted.[12]

  With the increased usage of laser printers, mills without de-inking systems have been left at a disadvantage. To remain competitive, it is expected that some mills will upgrade their facilities to include de-inking capacity. This process takes an average of three years to

complete.[13] Scott Paper, as one example, has recently announced the addition of new de-inking capacity.

- Scott Paper Ltd. of Vancouver. This firm reports purchasing an undisclosed tonnage of white and coloured ledger for manufacture of 25-100% recycled tissue and towelling under the label of "Cottonelle", "Cashmere", "Scotties", "Viva", "ScotTowels", "Scott Family Napkins", and "Scot" brand industrial.[14]

The decision to use less expensive secondary fibre as part of a mill's feedstock is based on economics. Recycled pulp is usually mixed with dried virgin pulp (market pulp) to form a pulp which is 10-60% recycled fibre.[15] Other mills make 100% recycled content paper which usually has a speckled appearance caused by the ink contained in the feedstock materials.[16] This product is less common due to continued consumer preference for clean, white sheet. The majority of both types of mills utilize only pre-consumer materials such as scrap and trim from converting and printing mills.[17] However, if the recent explosive increase in consumer demand for post-consumer recycled content fine paper is sustained, the dominance of pre-consumer fibres as a source of secondary material may change, resulting in increased demand for these secondary fibres.

Increased sales of tissue products and recycled content fine paper, coupled with mill expansion announcements, caused some industry fear that fibres would be in low supply. Since use of pre-consumer supplies was already at a maximum in the province, additional supplies had to come from post-consumer sources. Collection programs in this area are still not widespread, and total recovery of Ontario supplies is small. As a result, several paper companies began to operate their own collection programs in 1989. Domtar collects post-consumer paper from several office buildings in the Toronto area, while Cascades collects from federal offices in Ottawa. Fraser has also announced plans to begin a paper collection program in order to supply stock to a new de-inking mill which is under discussion.[18]

Fine paper mills utilizing secondary fibre include:

- Domtar Inc. of St. Catharines utilizes 3,600 tonnes of CPO (computer print out) per year in the manufacture of their recycled content writing and printing papers. The company was the first in Ontario to produce fine paper made of 100% recycled post-consumer content. No de-inking is used in the process. The end product is speckled, often coated with a grey or beige dye for a more consistent finish. Only CPO is used in this product. The company reported that the fibre length of other fine grades would not allow the formation of the product without the addition of some virgin stock. The company utilizes stock collected via their office paper collection program. This material is sorted and processed on site, into bales of CPO, white ledger and coloured ledger.[19]

- Fraser-Noranda Inc. of Thorold, Ontario purchases approximately 21,000 tonnes of post-consumer manifold, white and coloured ledger each year for the manufacture of their recycled content fine paper. The company's recycled content products include: "Fracopi", a 20% recycled content writing and photocopy paper, and a group of 50% recycled content office, book and printing papers as well as a form bond. Papers delivered to Norand are baled and sorted by an intermediate processor. Although the firm is capable of de-inking fibres, its equipment has no tolerance for contamination such as produced by hot melt glues which tend to clog the mill's screens.. Planned expansions should increase utilization at this mill to 42,000 tonnes per year.[20]

Fine grade materials are also used in the paperboard industry which produces boxes by recycling newspaper and corrugated cardboard. Fine paper is used in the formation of the outer liner of the box. The thin layer of fine paper appears as a bright, usually white, attractive outer surface which can easily be printed on. Gypsum board manufacturers also use fine paper to produce an attractive outer layer for their product. Mills that utilize fine paper for this purpose include the following (tonnages are unavailable):

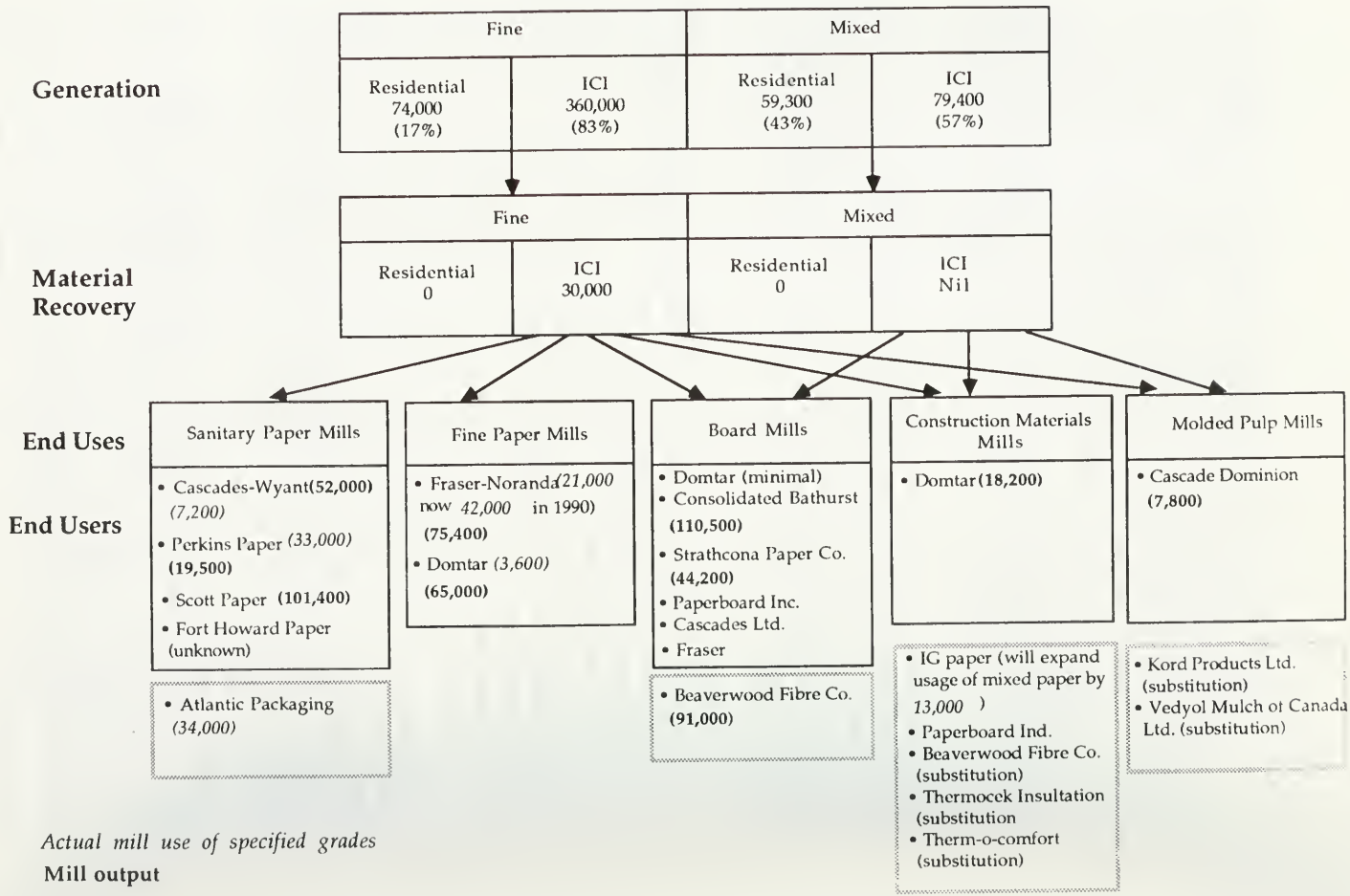
- Cascades Inc., of Quebec. The firm manufactures 90-100% recycled content boxboard from a mixture of fibres including white ledger.[21]
- Domtar Inc., of Ontario purchases a volume of CPO for manufacture of its linerboard product.[22]
- Consolidated Bathurst, of Quebec purchases white and coloured ledger for the manufacture of boxboard.[23]
- Fraser Inc., of Etobicoke purchases CPO for manufacture of boxboard.[24]
- Strathcona Paper Company, of Napanee, Ontario purchases CPO for boxboard manufacturing.[25]

In addition, post-consumer fine paper is used by several companies as a strengthener in their finished product. Quebec and Ontario Paper uses fine paper to improve the strength of their recycled newsprint and improve runnability (i.e. strength on paper machines).[26] Quebec and Ontario Paper is an active market for several fibre grades in addition to old newsprint. Similarly, fine paper is used for strength in the manufacture of new corrugated linerboard.[27]

Because fine paper grades are relatively stronger (compared to other fibres), and have little contamination, they are be a preferred source of material for many Ontario mills. This is reflected in the high price commanded by fine paper compared to mixed paper, OCC, and ONP.

Figure 4.1 (overleaf) profiles the generation, recovery, end uses and users of fine paper and mixed paper (discussed in Chapter 5).

Figure 4.1
Fine and Mixed Paper (tonnes per year)
Ontario 1989



Actual mill use of specified grades
Mill output

4.2.2 Factors Affecting Demand for Fine Paper

Key factors that effect mill demand for post-consumer fine paper are:

- cost of virgin pulp
- consumer demand for fine paper and sanitary paper with recycled content

The primary factor affecting the demand for post-consumer fine paper is still the cost of virgin pulp. High grade secondary pulp is priced between $100 and $150 less per tonne than virgin pulp, providing significant savings for mills that utilize it in place of virgin materials to produce fine grade paper.[28] However, the end product produced with secondary fibres is typically of lower quality than its virgin fibre counterpart.

Further savings can be realized if a mill has the capacity to de-ink secondary fibres. A mill that is capable of de-inking can save on fibre costs and pulping chemicals. High grade fibres are currently available at sufficiently low prices to justify using them instead of virgin materials. In addition, the de-inking process requires much less water, energy and chemicals than pulping virgin materials, adding to the cost savings.29

To RIS's knowledge, there is only one firm in the business of manufacturing and selling high grade pulp: Ponderosa Fibres of the U.S. This firm has many mills across the U.S. and supplies pulp to mills that require secondary fibre pulp and do not have the facility to produce it themselves. This firm has continuously lost market share over the last few years, as larger mills have begun to install their own de-inking capacity. This indicates that mills believe there is a cost savings in installing on-site de-inking capacity. Ponderosa continues to supply pulp to small mills, indicating that the installation of small capacity de-inking machines may not be cost effective.

De-inking mills designed for fine paper tend to be less expensive than those for lower value materials.[30] For instance, in mills that de-ink ONP, much of the cost is in fibre cleaning equipment. Finer grades do not require extensive cleaning equipment. For the most part, these fibres are separated at source, and kept dry, resulting in less contamination.

Consumer demand for recycled content materials has the potential to influence mill demand for pre-post-consumer materials. The development of the Environmental Choice Program is expected to be a stimulus to increased use of post-consumer fine paper. Certification to use the logo requires a minimum of 5% post consumer waste in the product. Mills have been using pre-consumer materials for many years, however these supplies

are currently being utilized close to their availability as previously discussed In order to satisfy existing capacity, waste fine paper is imported from the U.S.

4.2.4 Price/ Elasticity Analysis

Fine paper in the form of mill-broke, cuttings, clippings and unprinted finished stock has long been used by the pulp industry as a substitute for virgin fibre. The primary impetus to collecting this commodity was financial: it could be obtained at a fraction of the cost of bleached virgin fibre pulp. This "wastepaper" type is of little interest to policy-makers, since it does not find its way into the waste stream. Post-commercial consumer waste paper has been recycled for many years, but very little separation of the various components of office "mixed" waste paper took place until recently.

Unsorted, office mix is a low-value secondary material. Certain types of wastepaper often found in office mix are, however, of relatively high value (e.g. non-laser printed bond, computer print out). Post-residential consumer fine paper is largely landfilled at present.

Elasticity of Demand Issues

Re-pulped fine papers can be used as substitutes for virgin fibre pulp in the manufacture of a range of paper products, including some higher grade fine papers. The fine paper waste may be de-inked (and perhaps re-bleached) in order to achieve the desired finished product brightness.

As shown in Table 4.2 significant quantities of "de-inking" grades of waste paper are consumed in Ontario. A large portion of this consumption is imported from the United Sates. This indicates that providing delivered prices are competitive with imported waste paper, a significant opportunity exists for the utilization of greater quantities of fine office waste paper.

Certain types of fine office waste paper cannot be accepted by firms manufacturing higher grade products because they are difficult to de-ink. Laser-printed paper, for example, cannot be de-inked by the usual "floatation" process. This greatly restricts the size of the potential market for these types of paper, or indeed, for batches of office waste paper that may be "contaminated" with them. This being the case, the best end use (and hence highest market value) for these types of office waste paper is containerboard, boxboard, corrugating medium, construction materials and the like.

In effect, certain types of fine office waste paper that cannot be de-inked fall into a lower grade of waste paper. For this category of fine paper, the relevant market price is that applicable to waste paper that is not normally de-inked because brightness is not required in the final product.

In sum, the demand for fine paper must be separated into two categories, "de-inkable, separated" and "non de-inkable, mixed". Manufacturers of fine paper and sanitary paper can use the former type of waste paper provided it is uncontaminated. For them it replaces virgin fibre or, more likely, "pulp substitute" and "de-inking" grades of waste paper.

The latter category of waste fine paper can be used to manufacture lower value added products like corrugating medium and construction papers. In these applications they are substitutes for virgin fibre, mixed waste paper, OCC and to a small extent, ONP. The cross-price elasticities for all these potential inputs are relevant to potential demand for waste fine paper. Insufficient publicly available data precluded the calculation of these elasticities here, however, the same market principles described for ONP apply to the demand elasticity for fine paper.

Table 4.2

Ontario Market for Recycled Fine Paper 1980-1989

Year	Price[1] ($'89/t)	Tonnes[2] (;000)	Growth (%yr/yr)	Year	Price[1] ($'89/t)	Tonnes[2] (;000)	Growth (%yr/yr)
1980	n.a.	114.1	—	1985	182.81	136.9	(6.9)
1981	232.54	116.9	2.5	1986	175.63	151.6	10.7
1982	210.44	118.0	0.9	1987	168.26	159.1	4.9
1983	198.41	147.1	24.7	1988	161.71	173.2	8.9
1984	188.60	147.1	0.0	1989	154.00	n.a.	n.a.

Notes:
1. Average July prices paid in Toronto for printed bleached kraft paper (sorted, baled, delivered, f.o.b. dealer gate).
2. High grade de-inking waste paper and pulp substitutes.

Source: OFIA 1989, *Recoup*.

Elasticity of Supply Issues

As with other waste commodities, offices will continue to pay for the collection of recyclable fine paper up to the point where the cost of recycling equals the cost of alternative disposal. If the cost of disposal via municipal facilities is not equal to the LRMC of landfill (or incineration), behaviour will be encouraged that can result in inefficient utilization of recycling opportunities.

The cross-price elasticity of supply associated with the price of disposal is thus one of the factors relevant here. Each potential source of fine paper secondary material has associated with it a cost of "production". This unit cost is low where collection, sorting, baling, transport and cleaning/de-inking is easy (e.g. waste from paper manufacturing and printing firms). Costs rise with increasing degrees of difficulty in the "capture" process. Hence, the price offered for office paper varies with the specific characteristics of the secondary material available. The price can, and often is negative, in that collection firms must provide containers, labour, transport and sorting services before the secondary material can be marketed.

Reclamation of office waste paper has been practised in Canada for a short time, and on a restricted geographic basis. Limited data on prices and quantities of the "mixed waste" category of waste paper are available and are not directly applicable. Ideally, office recycling programs should be geared to the production of the highest grades of waste paper possible by sorting office mix into its components. The price and quantity data shown in Table 4.1 are for "de-inking" grades. Traditionally, these grades do not consist of office waste paper, but if subjected to sorting, office fine waste paper would fall into this category.

The price currently obtained for waste fine papers is low or nil. (Recoup reports prices paid for de-inking grades of waste paper (f.o.b. dealer gate) to be about $154/baled delivered ton. This information corresponds to that given by firms engaged in the office waste paper collection industry. These firms also noted that if the waste paper supplier (e.g. an office building) requires that the paper be picked up, no compensation is offered, even for the highest quality office paper grades). At present, offices and commercial establishments wishing to divert their discarded paper from the waste stream must pay for collection and delivery to paper brokers or end-users. Firms engaged in fine paper collection will pick up office waste paper "at the loading dock" for anywhere from $44/tonne for mixed waste to free of charge for sorted, high grade waste paper (e.g. computer print out).[31]. Other charges may apply in addition to this basic cost, depending on conditions. The provision of containers, collection labour, etc. are available at extra cost. Per unit charges might be higher if access is difficult, volumes are small, or only low value paper is available.[32]

No firm estimates are available for the quantity of recoverable fine paper potentially available in Ontario. Per capita consumption of these paper types exceeds 50 kg per year, but the volume of sorted fine waste paper that could be obtained under optimal collection conditions would be far less. Estimates of fine paper consumption in Metropolitan Toronto, for example, exceed 110,000 tonnes, while estimated recoverable fine waste paper is 20,000 "at best".[33]

This estimate is suggested to represent economically recoverable supplies under current conditions, that is, with existing collection, sorting and delivery practices and techniques. More efficient means of capture would result in higher recovery rates, as would higher costs of alternative disposal options.

4.3 *Assessment of Market Capacity to Absorb Supply*

Ontario demand for fine grades is currently much greater than available domestic supply; however the global market for these materials is experiencing a glut. Ontario mills are filling their orders with a combination of pre-consumer and U.S. materials. By 1995 local mill capacity for office grades is projected to increase by 248,000 tonnes.[34] Increases in material utilization are expected to continue after 1995, providing ample market capacity to absorb the 215,900 tonnes of fine paper projected to be recovered annually in Ontario by the year 2000.

As with ONP, the fact that local demand and supply estimates indicate favourable conditions for fine paper does not necessarily indicate that provincial fine paper supplies will be favoured by local mills. There is a possibility that larger, less expensive supplies will be available to these mills from other sources.

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5.0 *MIXED PAPER AND BOXBOARD*

5.1 *Supply*

5.1.1 Generation

Mixed paper refers to a combination of various grades including treated and coated stock. In addition, boxboard (used for cereal and cracker boxes etc.) has been included in this category because of similar recovery limitations.

Current Generation

CH_2M Hill estimates that in 1989 mixed paper constitutes 59,300 tonnes or 1.46% of the residential waste stream and 43% of all mixed paper. Mixed paper includes a range of paper grades and its share of the waste stream varies depending on what is being included. As a result, it is difficult to compare this figure to those of other studies. Mixed paper in the ICI sector totals 79,400 tonnes based on Canadian Pulp and Paper Association data for total mixed paper in Ontario.

According to the Canadian Pulp and Paper Association, approximately 507,000 tonnes of boxboard were consumed in Ontario in 1989. This works out to 44.9 kg per household.

CH_2M Hill estimates that boxboard consists of 4.27% of the residential waste stream, or 173,100 tonnes. Residential boxboard represents 34% of all boxboard. The amount of boxboard generated in the ICI sector is calculated as 333,900 tonnes the difference between the provincial consumption and the residential sector estimate.

Projected Generation

Mixed paper and boxboard generation estimates for the next decade were calculated by assuming the 1989 proportion of each material to the total waste stream to remain constant and household generation stays at 15.4 kg per year. Thus, residential and commercial generation of mixed paper in 1992 is expected to be 61,915 tonnes (15.4 kg x 4.026 million hhlds) and 82,890 tonnes in the ICI sector in 1992. By 2000, the corresponding estimates are 67,300 tonnes in the residential sector and 90,120 tonnes in the ICI sector.

Using the same methodology, boxboard generation in the residential sector is estimated to be 180,770 tonnes (44.9 kg/hhld x 4.026 million hhlds) in 1992 and 196,470 tonnes in 2000. In the ICI sector, based on its 66% share of the total boxboard stream, is estimated to generate 348,695 tonnes in 1992 and 379,000 tonnes in 2000.

5.1.2 Current and Projected Diversion Recovery

Current Diversion

In 1989, mixed paper in the ICI sector was not as a rule targeted for recovery by material collection firms. However, in the process of collecting fine grade paper some material which can be classified as mixed grade is included. Under these circumstances, it is not possible to estimate the amount of mixed grade paper which becomes part of the fine grade collection program. (Thus Table 5.1 indicates 1989 ICI diversion as unknown.) Mixed paper generated by householders is currently not collected for recycling.

Post-consumer boxboard collection activity in the province is minimal. One pilot collection program is operating in Centre and South Hastings Ontario. Boxboard collected at curbside is accepted by Paperboard Industries and Shathcona Paper to test its recyclability in the boxboard manufacturing process. Post-consumer boxboard is used in the production of lower value end products. To RIS's knowledge, this is the only post-consumer boxboard recycling program operating in North America, with the only mills accepting this material. Results of the boxboard trials are inconclusive, but suggest that considerable work needs to be done to sort boxboard to remove contaminants.[1] Thus, it is not expected that there will be significant opportunities to recycle boxboard in the short to medium term.

Projected Diversion

Collection of mixed paper from offices may be achieved through office programs. The challenge is to ensure that it is effectively diverted from landfill. Waste collectors competing for office business collect all grades of paper. Since there is almost no market for this grade within Ontario, most collectors sell it to brokers who supply major tissue makers such as Fort Howard Paper and Scott Paper with tissue mills in the U.S. The ban on mixed paper from Metro landfill is to take effect on July 1, 1991 and this is expected to significantly increase diversion in the GTA.[2]

In terms of boxboard, RIS estimates that diversion of this material will slowly increase during the study period as long as recycling is not fully viable. Collection would have to be driven by strong secondary material markets which are not available currently for boxboard. Hot melt glues present a manufacturing problem, resulting in a lower grade of end product. The percentage of boxboard in Ontario's waste stream is not likely to change over the projection period either. Table 5.1 summarizes current and projected generation and diversion rates for mixed paper and boxboard. However, the Paper and Paperboard Packaging Environmental Council (PPEC) is examining

alternative markets for the diversion of boxboard including composting and animal bedding.[3] Until these other markets develop and have capacity to recycle boxboard, recovery is expected to remain modest. Some diversion in the ICI sector can be expected however, predominantly in the GTA. This is due to high tipping fees, although it is not clear where these wastes will go.

Table 5.1

Mixed Paper and Boxboard Generation and Diversion Estimates for Ontario (tonnes/year)

Mixed Paper	1989	1992	2000
Residential Generation	59,300	61,915	67,300
Residential Diversion	0	0	0
ICI Generation	79,400	82,890	90,120
ICI Diversion	unknown	15,700+	15,700

Boxboard	1989	1992	2000
Residential Generation	173,100	180,770	196,470
Residential Diversion	0	36,150	98,235
ICI Generation	333,900	348,695	379,000
ICI Diversion	unknown	unknown	unknown

*see text 5.1.3 re: forecasts

5.1.3 Potential for Increased 3R's Activity

Reduction

Reduction opportunities for mixed paper and boxboard consist of changes in the way materials are currently packaged, and reduction in the distribution of junk mail to households. It is anticipated that virtually all boxboard generated by offices and households is a result of packaging, which could be targeted for reduction under the National Packaging Protocol (NAPP).

Recycling

Recycling boxboard into boxboard is difficult with current technology, while recycling this material into other products has not yet been fully explored. Increased reduction in use of boxboard packaging may occur over the study period, but RIS is unable to predict this change with any accuracy. Similarly, increased recycling will depend on technological and innovative advancements to overcome the current processing difficulties experienced

with this material. However, it is expected that NAPP should drive diversion of boxboard packaging and therefore a 20% diversion by 1992 would result in 36,150 tonnes of boxboard from the residential sector. The parallel for 2000, when the diversion target is 50% is 98,235 tonnes. It is not known how much of this will be generated through each of the 3Rs and therefore the quantity from recycling which will be looking for a market.

The recyclability of mixed paper could be increased by reducing the use of contaminating coatings and treatments. Reduction of household flyer deliveries could also be pursued. Again, whether these changes will occur in the study period is unclear. However, landfill bans on this grade of paper are forcing collectors and haulers to increase diversion of this material. With significant proportions of mixed paper generated in southern Ontario where such bans are in effect recovery should increase rapidly. However, in the absence of any hard information since the Metro Toronto ban will only be fully effective on July 1, 1991, we have not been able to estimate diversion potential for ICI beyond the 15,700 tonnes reported by CPPA. (See Table 5.2). However, for the residential sector where blue box habits are well developed, one could make some assumption about total diversion levels, say 20% in 1992 and 50% by 2000. More could be achieved through mandating these materials, but this is a starting point.

5.2 *Demand*

5.2.1 Market Structure

Boxboard will not be included in this discussion, since it has no market outside of a pilot scale arrangement between Centre and South Hastings and Paperboard Industries.

Post-consumer mixed paper is a low value material in Ontario, but has value particularly to tissue makers in the U.S. ONP has displaced mixed paper in Ontario in 1989 and 1990, but ONP cannot be recycled into tissue products.

Ontario markets for mixed grade have traditionally included manufacturers of boxboard and roofing products. In recent years, usage of mixed grades by North American mills has fluctuated widely, with a dramatic decrease in the past five years. Between 1986 and 1988, consumption of recovered mixed paper dropped from 33.1 tonnes/year to 17.0 tonnes/year, representing a decline of almost 50%, although it is likely that this is an inflated figure, and that some decline was due to poor reporting procedures by end-users.[4] Similarly, Ontario industries have shown a reduction in use of this fibre grade from 25% of the total fibre furnish when markets were strong, to 12% currently.[5]

The reason for this dramatic decline is the old newsprint glut. Boxboard and roofing product manufacturers have almost completely switched from mixed grades to old newsprint, taking advantage of the competitive prices brought about by the considerable over-supply of this material. Moreover, there is a strong preference for old newsprint over mixed paper because it is less contaminated and easier to manage in the manufacturing process. Section 5.2.2 analyzes this relationship to ONP in more detail.

The decline of mixed paper consumption can also be explained in some areas by the collapse of the organic roofing materials industry (e.g. roofing materials made of recycled paper fibre mostly). During the 1980s, fiberglass and other different types of roofing materials gained industry-wide popularity and largely replacing mixed paper in the roofing industry. Only recently has the organic roofing market regained some of its lost market share. It is clear that this force had an effect on the utilization of mixed paper in the U.S. However the impact on Canada is not well documented.

Current utilization of mixed grade in Ontario remains low; however demand is expected to increase slowly during the 1990s assuming the old newsprint glut situation is rectified.[6] Local supplies are recovered entirely from the ICI sectors, as is the case across North America. A growing volume of the material collected is from document shredding services, and is sold to end users either baled or loose. ICI collections are more popular than household programs because of the higher value of the paper collected. In the absence of firm data on which to base projections, no estimate has been developed. Thus, Table 5.1 shows 0 as the diversion in 1992 and 2000.

5.2.2 Factors That Influence Demand for Mixed Paper

The main factors affecting use of mixed paper are:

- price and availability of old newsprint;
- price and availability of old corrugated cardboard (OCC);
- legislation requiring mandatory recycling and recycled-content;
- consumer demand for recycled packaging;
- strength of the organic roofing market;
- technologies for the separation, cleaning and pulping of mixed paper grades.

As mentioned, collection of mixed paper is expanding, particularly in the ICI sector. Mixed paper is not collected at curbside in the province.

As long as the price of mixed paper remains between $0-10 per tonne, having recently dropped from $40 per tonne, recovery of this grade will not occur at any significant level.[7] The price is likely to remain low until the fibre markets in Ontario absorb the old newsprint glut, expected in the near future

as new de-inking mills become operational. This absorption is expected to increase the price of old newsprint, which in relative terms will make the price of mixed paper more competitive, and therefore increase the likelihood of mills considering fibre material substitution in the manufacturing process. However landfill bans only increase supply, depress prices and in the absence of large markets in Ontario, force collectors to broker mixed paper for export.

Mixed paper, in some instances, can also be used as a substitute fibre for OCC. In fact, several far eastern Canada mills use 100% recycled mixed paper grades to manufacture corrugated containers. Should OCC become in short supply, mixed paper demand would increase.

The market for products made of recycled mixed paper have a significant influence on the demand for this grade. For example, because the organic roofing and molded pulp market were large consumers of mixed paper, the strength of these markets has an influence on the demand for the mixed paper grade.

Recycled content and procurement legislation may have an impact on the boxboard packaging industry which is a major user of mixed paper predominantly generated from cuttings, off spec material, etc.

The trend toward recycled content in newsprint is however difficult to repeat for boxboard which is already made of virtually 100% recycled fibre.

Many boxboard mills in Ontario, such as the Beaver Wood Fibre Co., Paperboard Industries, Sunoco, and Strathcona Paper already use large quantities of recycled paper; however the fibres used include mostly higher value materials than mixed paper. Moreover, their use of different grades fluctuates depending on price and availability. As mentioned, Paperboard Industries is currently conducting a pilot project, using post-consumer boxboard as a feedstock in their mills, but results so far are not encouraging.[8] Several manufacturing problems caused by hot melt glues have been cited as the main issue thus far.[9] PPEC is working with glue manufacturers in an effort to address this issue.

If technological advancements in boxboard recycling can solve the current processing issues, the result could be increased demand for mixed grades. New techniques which could improve fibre quality as well as products made from mixed fibre and would make this grade more attractive to buyers. Advancements in both collection, processing and mill technology are needed to accomplish this.

Current processing technology for mixed paper grades is considerably slower than that used for OCC and old newsprint, thereby increasing production costs. Not only is the final mixed paper product relatively more expensive, it is less durable, typically two-thirds the strength of a product made with OCC.

Better pulping techniques are required to improve pulpability of mixed paper and the strength of the final product. Technological barriers in the manufacturing process serve to limit the growth potential of mixed paper usage.

5.2.3 Factors That Influence Choice Between Primary and Secondary Materials

Mixed paper grades are used by mills in processes that have higher tolerance for contamination, and can accept heterogenous feedstock mixes. The sale value of the end product also plays a major part in the equation which determines the price a mill can pay for feedstock.

Boxboard contains secondary fibre for cost reasons. However most of its fibre was not sourced from post-consumer waste due to the contaminants. Virgin fibre is not a substitute in this product area. However given the supply of both industrial and post-consumer secondary fibre, the former is preferred because of its lower level of contaminants.

5.2.4 Price/Elasticity Analysis

Recyclable paper, including unsorted fine paper, generated by homes, offices and commercial establishments is generally considered to fall into the "mixed waste" category by consumers of secondary fibres. Mixed paper typically contains short (low strength) and long fibres, coated (magazine) and uncoated papers, previously recycled paper, and a variety of contaminants, such as hot melt glues, plastics, sticky labels and assorted refuse.[10] As this is the lowest quality recyclable paper, it captures the lowest market value.

Elasticity of Demand Issues

Overall price elasticities of demand for this type of waste paper have been shown to be very low, if not nil (Anderson reports an own-price elasticity of 0.08. Gill suggests 0.00.)[11] The demand for products made from mixed waste paper appears to have a much larger influence on the quantities of mixed paper purchased on the secondary market than the price of mixed waste paper itself.[12]

Typically, mixed paper is used to make boxboard, newsprint cores, and construction paper products. These end products are, in general, made with secondary materials. Mixed waste paper and ONP are used to provide bulk for the finished product, while OCC provides stiffness. The more mixed waste paper that is used, the less ONP that is required in the production

process and vice versa. Consumers of mixed waste paper are, therefore, by and large "swing" purchasers. Changes in demand for mixed waste paper can be linked directly to changes in the price of ONP. The cross-price elasticity of substitution cannot be estimated from available data because of the rapid increase in the supply and decrease in the cost of "production" of ONP that has taken place recently.

Table 5.2 describes the changes over the past ten years in consumption of mixed waste paper. These are the latest available for this data set. Note the steady increase in consumption since the end of the recession early in the 1980s, indicating that usage tends to correspond with changes in GDP. Consumption fell in 1988 and after, due to the flooding of the "swing" market with ONP, as illustrated earlier in Table 3.3.

Processes are being developed that may result in wider uses for low grade mixed paper. The potential market for the output of these processes is difficult to estimate, but if successful, the impact in terms of absorbing current supplies of mixed waste paper could be large. A demonstration plant manufacturing absorbent material from mixed waste paper is scheduled to come on stream in February 1991. The product is intended to replace sawdust, clay and towelling in a variety of uses, from spill control to cat tray absorbent. The process is very tolerant of impurities (except metal), in that all input waste is processed through an autoclave in order to remove contaminants, including plastics, adhesives, etc.[13] This could result in the price of all grades of mixed paper waste rising significantly.

Table 5.2

Ontario Market for Recycled Mixed Paper 1980-1989

Year	Price[1] ($'89/t)	Tonnes (;000)	Growth (%yr/yr)	Year	Price[1] ($'89/t)	Tonnes (;000)	Growth (%yr/yr)
1980	n.a.	9.4	—	1985	nil	22.7	44.6
1981	45.68	7.9	(16.5)	1986	15.68	33.1	45.8
1982	nil[2]	6.0	(24.0)	1987	15.02	32.1	(3.0)
1983	nil	13.5	125.0	1988	4.04	17.0[3]	n.a.
1984	nil	15.7	16.3	1989	2.75	n.a.	n.a.

Notes:
1. Average July prices paid for low grade mixed paper in Toronto (sorted, baled, delivered, f.o.b. dealer gate).
2. Nominal prices paid.
3. A CPPA reporting problem caused a large contributor to the annual total to be excluded.

Source: OFIA 1989, *Recoup*.

Elasticity of Supply Issues

Mixed paper is a "catch-all" paper category, consisting of all grades of waste paper, from old newspapers to fine papers. As such, it is potentially available in volumes larger than any other single category of waste paper. In practice, most mixed waste paper is generally supplied from sources that do not sort paper wastes. Mixed waste, however, is by definition unsorted, but other higher grade waste paper types may have been separated out. Mixed waste paper produced as the by-product of sorting higher grades from batches of waste paper is termed "low grade mixed paper".

Analyses of the price elasticities of supply for "waste paper" have revealed that where the waste paper is collected by private firms, the estimated elasticity has consistently been reported as very low. That is, changes in price elasticity very little response in terms of quantities supplied to the market (voluntary recycling supply elasticities range from an estimated 0.23 to 1.70.[14] The same is not true concerning the reaction of municipal recycling programmes, which appear to be somewhat more responsive to price rises (the range is much smaller: 0.80 - 1.05.)[15]

As Table 5.2 shows, the price for low grade mixed paper is volatile, with wide fluctuations experienced between 1984 and 1989. The reason for this phenomenon is, in part, rooted in variations in demand for the components of mixed waste paper.[16] When demand (and hence price) for high grade waste papers is low, the benefit of sorting fine and other paper out of mixed waste is marginal. This benefit grows as the prices commanded by higher grade secondary materials rises. As more mixed waste is subjected to separation, the quantity of mixed waste available for sale declines. As the quantity available declines, the price of mixed paper can be expected to rise. The result is that the price of mixed paper tends to track the prices of its component grades, partially independent of changes in demand.

Better quality mixed waste paper can be obtained from commercial and industrial sources, where potential contaminants are readily identified, volumes are large, ad sorting at source can take advantage of any economies of scale. Mixed paper generated by households is, if not sorted, of potentially the lowest quality possible due to contamination. Hence, the potential for diverting mixed waste paper, produced by the commercial and industrial sectors, from landfill is much higher than for residential supply. Better source separation is required, especially in the household sector, before mixed waste paper can make major inroads in a market dominated by ONP. Policies to affect newspaper supply should concentrate on this aspect. For example, generator sorting into paper types as part of municipal "blue box" programmes should be encouraged.

5.3 *Assessment of Market Capacity to Absorb Supply*

The short and long term scenarios for mixed paper are very different. In the next few years, the mixed paper market in Ontario is likely to be driven by landfill bans. In the absence of demand in Ontario, export markets will be relied upon for diversion. Also, the demand for mixed paper is linked to the old newsprint market. Once the announced newsprint mills are in operation (as is expected in 1992), the demand for old newsprint is expected to exceed supply. As old newsprint prices rise, so too will the demand for mixed paper fibre will increase as ONP is bled away to the newsprint mills due to price. Boxboard and other users can be expected to look to mixed paper as a source of fibre.

A shortage of OCC in the future would also increase the demand for fibre substitutes. Given current levels of technology, it is expected new demands for mixed waste paper in the event of a significant OCC shortage are likely to come from the boxboard and export markets. The boxboard industry has the potential to use 40 to 50% mixed paper as furnish. It is estimated that a price difference of $7.00 per tonne would entice the boxboard industry to change from OCC and old newsprint to mixed paper.[17] Per tonne 1989 -1990 market prices for OCC, old newsprint and mixed paper range between $0-5, $0-10, and –$10-15 respectively. Thus, if OCC prices increased to $7.50-12.50 per tonne and old newsprint to $7.50-17.50 per tonne, mixed paper utilization should increase.

The boxboard industry faces a difficult task to recycle post-consumer boxboard. Alternate markets are being researched, but none yet holds enough promise to be economically viable.

The roofing materials market is expected to expand slowly in the 1990s, providing another opportunity for mixed paper use. The rebirth of fibre roofing materials is anticipated because fiberglass roofing materials did not perform as well as organic materials in cold climates. There is also concern over the health risks associated with fiberglass. In addition, consumers are showing a preference for products made from recycled materials and natural fibres, giving organic materials a marketing advantage.

Although organic roofing material manufacturers are using old newsprint as fibre furnish, mixed paper is likely to regain popularity as the main secondary fibre used by this industry. One roofing material vice-president felt that a price difference of $5/tonne would be a sufficient incentive for the industry to use mixed paper.[18] In other words, the old newsprint price would need to increase from its current rate of $0-10 per tonne to $5-15 per tonne.

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6.0 CORRUGATED CARDBOARD

6.1 Supply

6.1.1 Generation

The Canadian Pulp and Paper Association reports that 1,487,000 tonnes of corrugated cardboard was consumed in Canada in 1989. Given that the population of Ontario accounts for 37% of Canada's total population, consumption in Ontario is likely to be in the range of 550,000 tonnes.

CH2M Hill estimates that in the residential waste stream corrugated cardboard amounts to 109,000 tonnes. The remaining 441,200 tonnes was generated in 1989 by the ICI sector or 7.43% of the Ontario ICI waste stream.

Using these share of waste stream percentages for OCC, it is estimated that generation in 1992 will be 113,800 tonnes for the residential sector, and 460,900 tonnes for the ICI sectors. Similarly, tonnages generated in residential and ICI sectors in 2000 will be 123,700, and 501,100 respectively.

6.1.2 Current and Projected Diversion Levels

Current Diversion

The private sector has always been involved in OCC collection and recycling. In recent years, the number of private sector programs has increased dramatically due to increasing landfill tipping fees and prohibitions from municipal landfills as was discussed for other paper grades in previous chapters.

No statistics are available on tonnages recovered and recycled in recent years since these are not collected through a centralized source. From conversations with OCC program operators, RIS estimates that current private sector programs recover approximately 25% of the available OCC in Ontario, or 110,300 tonnes from the ICI sector.

Private firms concentrate on collections from large volume generators such as warehouses and retail operations, although this is changing rapidly with the emphasis on recycling and waste diversion supported by increasing tipping fees and landfill material bans, particularly in the GTA. Both municipalities and waste collectors are beginning to provide better OCC diversion service to small and mid-sized generators.

In 1989/1990, there were two curbside programs in Ontario that collected OCC. The City of Toronto estimates collection volumes from their program to be

1.61 kg per household served per year, or 312 tonnes per year for the entire City. The Region of Halton's program reports that OCC accounts for approximately 10% of the curbside materials collected from those households serviced, or 520 tonnes per year.

Thus, total current diversion of OCC from the residential waste stream is 830 tonnes.

Projected Diversion

RIS estimates that the number of municipalities which will prohibit OCC from landfill will increase over the study period. This, coupled with strong market demand for the material will increase diversion and recycling over the projection period. It is estimated that by 1992, 25% of the households serviced by a blue box program will be collecting OCC and by 2000, 50% of the households will be collecting OCC. Therefore, recovery rates estimated at:

1992 = 25% x 2.9 million hhlds x 1.61 kg/hhld, or 1,200 tonnes
2000 = 50% x 3.5 million hhlds x 1.61 kg/hhld, or 2,800 tonnes

It is estimated that 30% of commercial sector OCC will be recovered via recycling programs by 1992. By 2000 the percentage should have increased to 50%. Therefore, estimated tonnages diverted are 138,300 for 1992, and 250,500 for 2000.

It is unlikely that the relative percentage of OCC in the Ontario waste stream will change over the projection period.

Table 6.1

Corrugated Cardboard Generation and Diversion Estimates (tonnes/year)

	1989	1992	2000
Residential Generation	109,000	113,800	123,700
Residential Diversion	830	1,200	2,800
ICI Generation	441,200	460,900	501,100
ICI Diversion	110,300	138,300	250,500

6.1.3 Potential for Increased 3R's Activity

Reduction

At the ICI level many new trends for reduction in the use of corrugated containers are developing.[1] Some firms which previously used many different sizes of boxes to package their products for shipping have begun to streamline their packaging lines to use only one size of box. When empty, these boxes can be picked up from customers, and shipped back for reuse by the firm. Other firms ship their products to clients in reusable plastic coated corrugated boxes, and others make it a policy to receive their supplies in reusable boxes, made of materials other than corrugated, which are picked up by the supplier for reuse.[2] Since this trend is just beginning, and it is not known how widespread it is becoming, it is difficult to estimate the overall impact on OCC generation. There is expected to be some substitution effect away from OCC into other materials. If successful in the ICI sector, it may spread into the packaging of consumer goods, although the impact on OCC in the residential waste stream cannot be estimate.

Recycling

Until the above-noted reduction trends are sufficiently proven to be practical, recycling remains the primary means of waste diversion in both the ICI and residential sectors.

At the residential level, increased diversion could be accomplished by quickening the pace by which blue box programs in the province implement mandatory OCC collection programs. Current trends in the absence of a push from government suggest that collection of OCC could be enhanced.

6.2 Demand

6.2.1 Market Structure

Like ONP and fine paper, OCC is traded on a global market, being shipped long distances to buyers. These buyers include manufacturers of paper, paperboard, construction materials and molded pulp products. Like fine grades, the demand for OCC in the province vastly exceeds current supply generated through diversion. The Ontario market is well established and requires a yearly total of between 300,000 and 350,000 tonnes to satisfy demand.[3] Between 200,000 and 250,000 tonnes of this volume is imported, largely from the U.S.[4]

Once collected, OCC is sorted, baled and brokered to Ontario mills for use as feedstock in various products, as follows:

- kraft paper used by manufacturers for bags and wrap;
- tubes and core board used by manufacturers of tissue, towelling, giftwrap, textiles, etc.;
- containerboard materials used in the manufacture of corrugated boxes;
- recycled boxboard products used by packagers of cereals, mixes, tissue, etc.;
- gypsum wallboard liner and roofing felt used in home renovation and building;
- packaging materials used for shipping and sale of breakable objects such as fluorescent light bulbs, china etc.;
- flowerpots and bio-degradable gardening supplies used by greenhouses and garden supply outlets.

The principal use of recovered OCC in the province is in the manufacture of containerboard. Approximately 68% of the OCC consumed each year in the province is used in the manufacture of new containers; 30% is used to make boxboard and the remaining 2% is feedstock in sanitary and packaging paper, construction products and molded pulp.[5]

The term 'containerboard' refers to a group of materials used in the manufacture of corrugated containers, including linerboard, and corrugating medium. There are 4 mills in the province which utilize OCC in the manufacture of containerboard.

- Domtar is the largest recycling consumer of OCC in Ontario using a total of 196,000 tonnes of material per year. The company operates new corrugated cardboard mills in Trenton and Mississauga, which uses 60,000 and 72,000 tonnes of OCC per year respectively.[6] Domtar is a fully integrated company, operating an OCC collection and processing program in addition to its mill.[7]

  In 1987, the company received a grant from the Ontario Ministry of the Environment (MOE) to research an alternate collection vehicle design and system which would facilitate cost-effective OCC collection. A small packer truck was used to collect material from small generators but fuel costs and maintenance fees were prohibitive. A hooklift truck was tested, consisting of a 20-cubic yard open-top box. Operators found the design permitted easy loading over the side from dock areas as well as being cost-effective to operate and maintain.

  Currently, a variety of generators within a 30 mile radius of the Mississauga plant are serviced. These firms include wholesale importers, furniture stores, distributors, light fabricators and retail

outlets. Generators must have 500 pounds per collection in order to receive service. One truck and a driver service the route, collecting approximately 100 tonnes per month.[8]

- Atlantic Packaging operates a containerboard mill in Scarborough, Ontario, which purchases an undisclosed quantity of OCC for use as feedstock. The mill has a yearly product capacity of 82,000 tonnes.[9] Approximately 95% of the OCC purchased is post-consumer. The remaining 5% consists of pre-consumer mill offcuts.[10] All purchased OCC is used in the manufacture of white/almond coloured high grade tissue for the grocery market. No industrial grade products are made.

- Paperboard Industries operates a containerboard mill in Glen Miller, Ontario. This mill has an annual product capacity of 60,000 tonnes; the volume of OCC purchased each year is undisclosed. [11]

In addition, there are several containerboard mills in Quebec which may use Ontario OCC fibre:

- Canadian Pacific Forest Products: yearly product capacity of 65,000 tonnes.[12]
- Cascades: 3 mills with yearly product capacities of 78,000, 23,000 and 34,000 tonnes.[13]
- Kruger: yearly product capacity of 65,000 tonnes.[14]

There are four boxboard mills in Ontario which utilize OCC in their operations:

- Beaver Wood Fibre operates a mill in Thorold with a yearly product capacity of 91,000 tonnes. The company purchases OCC for this operation, and in addition, uses OCC for the manufacture of paper liner for drywall. Total yearly OCC usage is 53,000 tonnes.[15]

  OCC is sourced through brokers: 65% from the U.S. and 35% from Canadian generators. Although the company finds that fibre prices are generally less in the U.S., it targets as much Ontario fibre as possible. Current barriers to using increased local supplies include a high degree of bale contamination from beer cases. The company's quality specifications include no tolerance for beer cartons and hotmelt glues. Prices paid for U.S. stock were $50, including delivery to the Thorold mill.[16]

- Paperboard Industries has boxboard capacity at two locations in Ontario. Total yearly product capacity is 117,000 tonnes. Information regarding actual tonnages of OCC purchased or

purchasing arrangements was not available. The company did report that both domestic and U.S. OCC are purchased. Quality specifications prohibit materials with wax coatings, tar tape, and hot melt glues, and restrict the amount of lower quality Asian corrugated accepted. Prices quoted to RIS were $30 per tonne, including delivery to the mill door.[17]

- Strathcona Paper operates a boxboard mill in Napanee, Ontario. The mill has a yearly product capacity of 44,000 tonnes, and purchases a combination of OCC, kraft and over-issue news. No details were available on pricing, brokerage or transportation arrangements.[18]

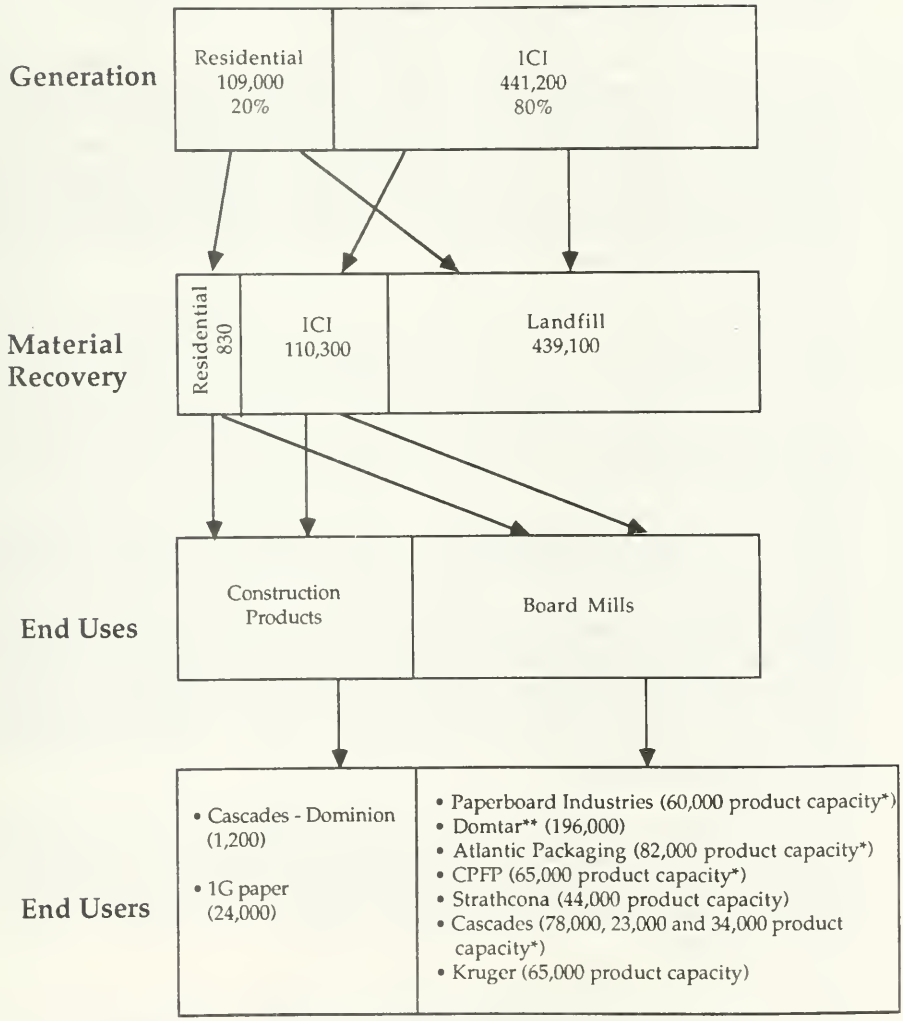
There are many other users of provincially generated OCC:

- I.G. Paper purchases 24,000 tonnes of OCC to manufacture shingles. 60% of this feedstock is generated within 50 miles of the mill. All material is reported to be post-consumer, purchased through various brokers. Quality specifications include no tolerance for beer cartons. Prices paid were not provided to RIS.[19]

- Cascades purchases 1,200 tonnes of OCC yearly for use in two types of mills: sanitary tissue and molded pulp. OCC is used as a feedstock in industrial grade sanitary products, and molded products. Approximately 50% of this material is derived from post-consumer sources. Material is sourced through a combination of brokers, dealers, paper collectors and a processing operation owned by Cascades. Quality specifications are similar to the Paper Stock Standards, which are published specifications for various fibre grades. RIS was not provided with information on price agreements.[20]

Figure 6.1 provides a summary of Ontario markets for OCC.

Figure 6.1
Old Corrugated Cardboard (tonnes per year)
Ontario 1989



* Yearly Mill Output
** Yearly Utilization of OCC

6.2.2 Factors Affecting Demand for OCC

The market for OCC is demand driven, responding less to supply issues. Economic factors are the main forces that act to increase OCC recovery and consumption. Increased containerboard demand, virgin fibre costs, the export market, and mill expansions all act to increase the demand for OCC.

Increasing disposal fees, and landfill material bans act to increase local supply. Locally-generated supply can be increased by incorporating more commercial and industrial generators into existing collection programs. Current technology, as noted by Beaver Wood Fibre specifically, prohibits the inclusion of waxed, coated or organic stained OCC in the recycling process. This limitation will be an issue in the near future as the market share of box material containing coated printing surfaces which can be displayed at the point of purchase, increases.

The mills described above must satisfy several strict specifications for product strength, and appearance. These qualities are achieved by a feedstock formula used to manufacture the end product. To meet these standards, it may be necessary to utilize a defined combination of fibres, each with their own specific set of qualities. Therefore, the an overall increase in the supply of OCC may not satisfy manufacturers who require specific volumes and types of material.

Managers of most mills suggested that if current prices for fibres currently used as resources in the manufacturing process were to increase substantially, they would have to examine the possibility of using less expensive alternatives. Not all mill operations, however, are capable of making such adaptions. Sanitary paper mills suggested that they have never had the occasion to replace OCC with a less expensive material before. Shingle manufacturers suggested that beer cartons were tried before unsuccessfully, and that for further substitutions to be tried, the price of OCC would have to be substantially increased.

In general, some substitutions for OCC may be possible, but since paper machines are tailored to use specific grades of waste paper and to produce a particular range of end products, substantial change would require significant investment in re-tooling of machinery and would not be undertaken without study and analysis.

6.2.3 Factors Affecting Choice Between OCC and Virgin Pulp

Unbleached linerboard has traditionally been made from either softwood or hardwood pulp. Recently, there has been an increase in the amount of

recycled fibre used to make linerboard. In the 1970s, the average utilization of waste paper in this process amounted to 4% of the total fibre furnish. Currently, 13% of fibre furnish consists of waste paper grades.

These waste paper grades usually consist of a combination of OCC and kraft paper. Usage varies from mill to mill, but the maximum amount of waste paper grades utilized are generally not over 25% of the total fibre furnish. However, there are mills that currently manufacture 100% recycled content linerboard.

The main motivation for building recycled linerboard capacity is the low capital cost of new mill construction. An American industry trade journal estimated the cost of adding pulping capacity to an existing mill to be approximately $250,000 per daily ton of capacity versus $400,000 per daily ton of capacity for the construction of a kraft linerboard mill using virgin fibre, primarily due to the differences in cost of pulping secondary versus virgin fibre.[21]

6.2.4 Price/Elasticity Analysis

Elasticity of Demand Issues

Old corrugated cardboard (OCC), because of its usual cleanliness and the strength of its long (originally kraft pulp) fibres, has many uses, including the manufacture of corrugating medium. Other uses include paper towelling, boxboard, construction materials and moulded pulp products.

Total OCC consumption in Canada in 1988 was about 476,000 tonnes, of which approximately 70 per cent went into making new containers. Another 30 per cent is used in manufacture of boxboard. The remainder (i.e., less than 2%) is consumed by makers of other papers and boards, including sanitary and packaging papers.[22]

Table 6.2

Ontario Market for OCC (and similar wastepaper grades) 1980-1989

Year	Price[1] ($'89/t)	Tonnes (;000)	Growth (%yr/yr)	Year	Price[1] ($'89/t)	Tonnes (;000)	Growth (%yr/yr)
1980	n.a.	309.4	—	1985	48.97	408.3	3.9
1981	95.51	322.9	4.4	1986	53.32	447.3	9.6
1982	71.40	296.3	(8.2)	1987	57.09	491.8	9.9
1983	67.32	348.5	17.6	1988	54.87	476.2	(3.2)
1984	64.00	392.8	12.7	1989	17.50	n.a.	n.a.

Notes: 1 Average July prices paid in Toronto for sorted baled OCC, f.o.b. dealer gate.
Source: Ontario Forest Industries Association, 1989, Recoup

In Ontario, the main consumers of OCC have a combined output capacity of 590,000 tonnes. Paper and paper products mills in Québec are also potential users of Ontario OCC. Most production processes that utilize OCC are designed with this feedstock in mind. Other inputs, including virgin fibre, can be used, but plants tend to be located to take advantage of commercial and industrial sources of OCC. Lower quality substitutes may also be available, but plants are designed to produce an end product with certain qualities, using inputs in narrowly specified combinations. In many cases, replacing OCC with lower grade waste paper is not feasible. Hence, the price of OCC substitutes does not have a strong influence on quantity demanded. SWEAP Discussion Paper #4 indicates that seasonal fluctuations in price, with lows experienced during peak Holiday Season shopping periods as supply increases, indicate the potentially strong cyclic nature of OCC demand. Increases in consumer spending accompanying rising employment and GDP will result in corresponding increases in demand for containerboard, and indirectly, for OCC.

In sum, demand for OCC can be characterized as relatively inelastic, especially in the short run. This might explain why increased demand for OCC following the termination of the 1982 recession was accompanied by high prices for OCC in 1984. As the rate of increase in demand slowed, real prices dropped back, as shown in Table 6.2

Elasticity of Supply Issues

The main sources of OCC are industrial plants, shopping centres, department stores, and commercial establishments. Corrugated box manufacturers supply cuttings as well, but these are not considered OCC in the strict sense. Canada consumed a total of 1,415,000 tonnes of containerboard in 1988, or some 55

kg/person.[23] The exact quantity of containerboard used and subsequently discarded in Ontario is not known. Included in such an estimate would be the net volume of containerboard imported into Ontario as product packaging, as well as net imports of containerboard products. If it can be assumed that net direct and indirect imports of containerboard are zero, this per captia consumption figure indicates that approximately 520,000 tonnes of containerboard is discarded in Ontario each year.

The supply of OCC is linked to the cost of disposal, as well as to the price obtainable for OCC on the secondary materials market as similarly described for other recoverable waste streams.

6.3 *Assessment of Market Capacity to Absorb Supply*

OCC has an established market in Ontario which is capable of absorbing more domestic OCC than is currently purchased, but would have to compete with imported supply which has an established customer base. As an established material for manufacturing paperboard and other materials such as sanitary paper and supplies for the construction industry, OCC will continue to be demand driven.

All industry sources including the Canadian Pulp and Paper Association and the American Paper Institute agree that demand for North American paperboard products is expected to remain strong in the 1990's. It is therefore expected that existing markets will be able to absorb all OCC recovered in Ontario.

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7.0 MAGAZINES

7.1 Supply

7.1.1 Generation by Sector

Current Generation

CH_2M Hill estimates that old magazines (OMG) amount to 165,100 tonnes or 4.07% of the residential waste stream (43 kg/hhld).

Magazine supply in the waste stream is difficult to estimate on the basis of magazine consumption. Some magazines are kept only for a short period, while others may be retained in libraries. Thus, RIS believes that the trend projection is the best estimate for magazines in the waste stream.

The CH_2M Hill study does not include a separate estimation of OMG in the ICI waste stream. RIS has estimated OMG in this sector based on data in an unpublished study for Metropolitan Toronto.[1] For 1990, the data indicate that about 30,000 tonnes of magazines were in the ICI waste stream based on a sample of 40 locations. Using these data magazines represent 13.3 kg per capita resulting in an estimated generation of 127,660 tonnes of OMG for 1989 for Ontario or 43% of the OMG waste stream.

Projected Generation

Projected OMG generation for the residential sector for 1992 and 2000, based on household growth and OMG waste of 43 kg/hhld is 173,100 tonnes and 188,200 tonnes respectively.

Based on its continued share of the OMG waste stream, magazine generation in the ICI sector is expected to reach 133,070 tonnes in 1992 and 144,600 tonnes in 2000.

7.1.2 Current and Projected Diversion Levels

Current Diversion

In 1989, there were no recovery programs for magazines, and in 1990 one program began in the Region of Halton. From January to June 1990, this program recovered nearly 260 tonnes of household magazines via curbside collection. RIS projected that yearly recovery for this program would amount to 520 tonnes. No industrial/commercial or institutional programs exist in the province for recovery of this material.

Projected Diversion

It is expected that the amount of magazine waste, as a proportion of the entire waste stream, will remain constant over the projection period. Readership is expected to stay constant. Some slight variation in total tonnage may occur due to the recent trend towards the use of heavier weight cover stock, but this would be modest.

Post-consumer magazine waste is problematic because of contaminants of glues and inks. However, magazine paper is highly valued because of it's strong fibres and the clays content. It is used in the production of recycled content newsprint in combination with ONP, where the fibres and clays contribute to the strength and finish of the sheet. Most paper mills producing recycled content newsprint from magazines source this paper from printers cuttings which avoids the contaminants of glues which are the primary source of problems when using post-consumer paper waste.

With the significant increase in newsprint production using secondary fibre, it is expected that demand for OMG will increase commensurately since it usually accounts for 15 to 35% of the total of secondary fibre. This in turn will drive demand for post-consumer magazines and price pressure should stimulate recycling programs to add OMG to blue box collections.

RIS estimates that by the year 1992, 20% of all households with blue box collection will have magazine collection. These programs will likely achieve diversion rates of 60% of total household magazines resulting in a provincial diversion of magazines of 14,964 tonnes (2.9 million hhlds x 20% x 60% x 43 kg/hhld). By the year 2000, magazines will likely be collected from 50% of households with blue box collection Assuming that with additional program promotion, capture rates will increase to 70%, the resultant provincial diversion will be 52,675 tonnes (3.5 million hhlds x 50% x 70% x 43 kg/hhld).

It is assumed that magazines from the ICI section will not be collected. Table 7.1 summarizes current and projected generation and diversion rates for magazines.

Table 7.1

Magazine Generation and Diversion Estimates for Ontario(tonnes/year)

	1989	1992	2000
Residential Generation	165,100	173,100	188,200
Residential Diversion	260	14,964	52,675
ICI Generation	127,660	133,070	144,600
ICI Diversion	n/a	n/a	n/a

7.1.3 Potential for Increased 3R's Activity

Recycling

The volume of magazines recycled in Ontario may be increased if the technological difficulties in processing this material are resolved. Difficulties include the processing of binders such as hot melt glues, adhesive labels and non-recyclable coated stock used by publishers. Printers and publishers could be encouraged to use recyclable alternatives to these materials. Many Canadian publishers are removing UV coatings on magazine covers to increase their recyclability but this is only part of the solution since over 60% of magazines originate outside of Canada.

Diversion could also be increased substantially if collection programs become widespread in the ICI sector, and if residential collection programs increased at a more rapid rate in the province.

7.2 *Demand*

7.2.1 Market Structure

Magazine recycling is in the early stages of development in Ontario. Previously considered to be 'mixed paper', magazines are just now emerging as a grade of their own. New interest in this fibre has recently been shown by newsprint manufacturers who plan to use this clay coated stock to strengthen their finished product

Because of its short history, there are no established markets or price trends for baled OMG, other than when included in mixed paper. Thus far, magazine recovery has occurred for pre-consumer grades, mainly for experimental purposes, as in Halton, and more recently in the Trenton

program According to a 1990 Environmental Defense Fund report, Quebec and Ontario Paper import pre-consumer magazine stock from the U.S[2] The Halton program provides Quebec and Ontario Paper with a small amount of residential magazines.[3] For the time being, however, Quebec and Ontario Paper is not pursuing other sources of domestic magazines.

Residential recovery programs for mixed paper (including magazines) are in place in 40 U.S. cities and towns.[4] These magazines are being utilized in flotation de-inking mills which produce recycled newsprint. The emergence of flotation de-inking technology will provide the largest market for waste magazines in Ontario. New newsprint mills currently under construction or in the planning phase will require 15-35% of their feedstock to be magazine stock.[5] The price for waste magazine grade is expected to rise to $55/tonne by 1991 as a result of this emerging market.

In Ontario and Quebec, several mills have been announced plans to purchase magazine stock. These mills expect to require magazines within the next year, and are listed below:

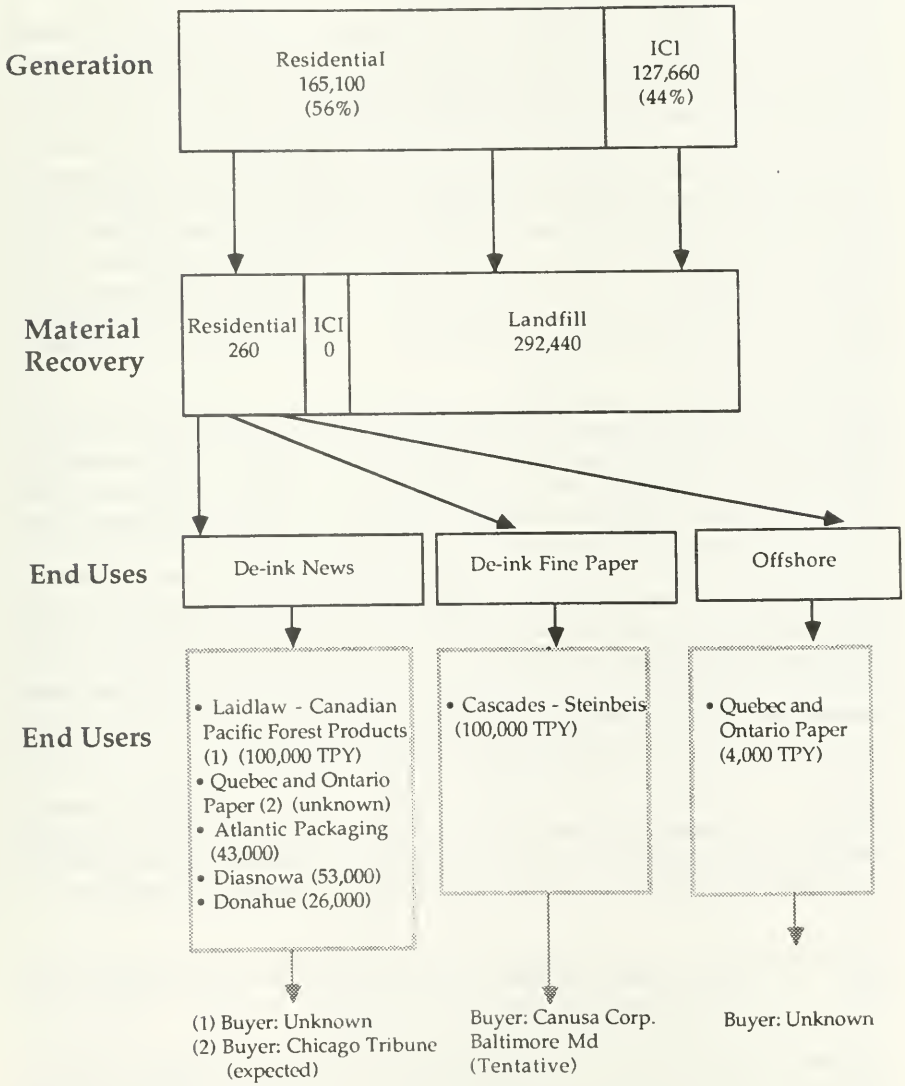
- Quebec and Ontario Paper, Thorold, Ontario (60,000 tonnes/year);
- Atlantic Packaging Inc., Whitby, Ontario (43,000 tonnes/year, starting early 1991);
- Canadian Pacific Forest Products, Gatineau (65,000 tonnes/year, starting in early 1991);
- Canadian Pacific Forest Products, Thunder Bay (35,000 tonnes/ year, starting in mid-1991);
- Daishowa Forest Products, PQ (53,000 tonnes/year, unannounced);
- Donohue Inc., PQ (26,000 tonnes/year, unannounced).[6]

As mentioned in the Section 3.0, Cascades-Steinbeis is planning to site a de-inking facility somewhere in North America. The facility will accept a variety of grades including magazines and will manufacture writing paper. The proposed production capacity is 100,000 tones/year.

In addition, Quebec and Ontario Paper is currently exporting magazines (about 4,000 tonnes/year) offshore.

Figure 7.1 provides a summary for Ontario markets for Magazines.

Figure 7.1
Magazines (tonnes per year)
Ontario 1989



7.2.2 Factors That Influence Demand

As the majority of the mills listed above will produce recycled newsprint, the demand for magazine grade is very much linked to the ONP market. The demand for recycled newsprint is expected to increase dramatically in response to legislative initiatives in the U.S. requiring newspaper publishers to use recycled content newsprint. Ontario paper mills will therefore increase their demand for OMG in tandem with ONP. This should stimulate the development of a market for post-consumer OMG.

The glues used in the binding and pressure sensitive labels for magazines are a contaminant to magazine recycling operations. The hotmelt glue sometimes used in bindings leaves deposits on the equipment and can cause blistering or spots in the finished product, which in turn, weakens the products' strength. In other areas, mills which have tried using post-consumer stock report that the glues are in fact not much of a problem. Jefferson Smurfit found that the clay residue helps to remove the adhesive contaminant.[7]

Technological developments that will allow waste magazines to be used in a wider range of applications, such as making coated stock, will increase the market demand for this grade. Some mills, such as Quebec and Ontario Paper are already experimenting with making coated paper with coated paper stock.

It should be noted that there is a potential change in the composition of magazines to incorporate recycled content and environmentally friendly inks. Some publications have already switched to recycled content paper. A U.S. publication, Garbage, uses 50-70% recycled content.[8] As more suitable recycled-content printing paper becomes available, it is expected that many more publications will switch to recycled grades. More research is required on the impacts of this change on magazine recycling in Ontario.

Legislative activity has yet to focus on the magazine publishing industry. However, in response to the recent flurry of activity in North America requiring newspaper publishers to include recycled content in their product, the Magazine Publishers of America has established a recycling task force.

7.2.3 Factors That Influence Choice Between Primary and Secondary Materials

As mentioned, markets for magazines do not exist in Ontario. This new market is solely the result of the recent trend of newsprint manufacturers to install flotation de-inking equipment which is considered state of the art at present and is therefore favoured.

The technology requires some input from magazines, because it requires the clay coating in this stock. There is really no opportunity for use of virgin fibre in place of this clay coated secondary fibre.

7.2.4 Price/Elasticity Analysis

Magazines are printed on ground wood paper coated with a thin layer of clay to lend a glossy finish to the sheet. Use of magazine stock involves de-inking which removes the clay outer coating. Clays which are not retained in the system settle out as sludge which is disposed of in landfill or as an agricultural "soil conditioner". The ground wood pulp left behind is then mixed with other fibres in order to improve the strength, opacity and brightness of the finished product.

Elasticity of Demand Issues

Coated magazine stock can be used as an additive to pulp made from old newspapers and/or virgin fibre pulp. Q & O began using pre-consumer coated paper in 1987. It contributes a portion of the total 55 per cent secondary fibre used in the production of newsprint. The remaining 45 per cent of pulp furnish is TMP from virgin fibre.[9] Used magazines and ONP are "complementary goods", since their demands function in tandem. In Ontario, the only current consumer of this type of waste paper uses pre- as opposed to post-consumer coated papers in its pulp furnish.[10] There are obstacles to the use of post-consumer magazines quite apart from the fact that at present, little effort is being made at the generator level to separate them from mixed paper or mixed waste. Post-consumer magazines are typically contaminated with staples or glue used for binding, adhesives from address labels, and glossy covers that cannot be stripped in the pulping process. Magazine stock available from printers and publishers however, can be supplied to makers of ONP in a much less contaminated form.

Two Ontario sources of demand (Halton and Trenton) for coated magazines are close to large urban centres, and are therefore potential purchasers of this fibre material.

ONP mills are operated by Québec & Ontario Paper in Thorold and Atlantic Packaging Products Ltd. in Whitby. The latter is scheduled to come on stream in early 1991. The exact amount of coated paper that can be used in the production of newsprint depends on the other components of the overall furnish. Québec & Ontario Paper reports that 55 per cent of their furnish is secondary fibre.[11] Since about 20 per cent of total feedstock comes from waste coated stock,[12] 35 per cent must be ONP, the balance being thermo-mechanical pulp from virgin fibre. At present, Q & O consumes an estimated 168,000 TPY

of ONP (RIS estimate). If this is 35 per cent of total feedstock, then coated paper consumption must be about 96,000 TPY.

The Atlantic mill will have an output capacity of 150,000 TPY, but unlike the Q & O mill, it will use only ONP and coated paper. Running at full capacity, the Atlantic mill will consume about 180,000 TPY of ONP.[13] The ratio of coated ground wood to total furnish is higher at Atlantic than for Q & O: about 30 per cent (Atlantic Packaging Products Ltd., will open its ONP mill in 1991, at which time the appropriate proportion of coated ground wood to ONP will be determined).[14] Atlantic can therefore be expected to require some 54,000 TPY of coated ground wood paper. In total, some 150,000 TPY of OMG could be consumed in close proximity to major generation sources in Ontario, providing these mills operate at full capacity.

This anticipated local demand greatly exceeds provincial supplies of coated magazine waste paper, including pre- and post-consumer grades. Municipalities should have little difficulty marketing their recovered magazines in the short run. Coated paper recovered via blue box program must, however, be made available on a consistent basis, in terms of both quality and quantity of supplies. The potential for acquiring total input requirements from sources outside Ontario is high, especially inlight of the fact that a large share of coated ground wood waste paper supply will have to be imported. In the longer run, the extent to which ground wood pulp (from which coated papers are derived) is produced from recycled paper could have a bearing on the demand for post-consumer magazines as a provider of strength to ONPP newsprint. If the qualities of the overall stock diminish over time due to reduced recycled fiber strength, substitutes may be sought.

Elasticity of Supply Issues

Post-consumer OMG is a new commodity which will require market development. While still in an experimental stage of development, it has been shown that proper sorting and the removal of hot melt glues can produce a magazine furnish comparable to pre-consumer stock.[15] It should be noted that the Atlantic paper machine, which employs more recent technology than that used at Q & O, may not be as sensitive to hot melt glue contamination, potentially obviating the need for cutting spines from recovered stock.[16] In its current form, this process is highly labour intensive, implying that changes in volumes of post-consumer magazine processed will be associated with proportionate changes in costs of "production". If hot melt glues are replaced with water soluble glues, unit costs will decrease substantially, but the relationship between quantity produced and costs will remain essentially linear.

The cost of processing post-consumer magazine relative to current prices offered for small volumes is high. Municipalities considering undertaking

magazine recovery should factor in the avoided cost of landfill, however, in making this decision. The Halton Region arrangement with Q & O Paper to supply the latter with post consumer magazine has resulted in the Region "breaking even" after consideration of these avoided costs. The economics of OMG recovery will likely vary among municipalities depending on the level of avoided cost.

Increases in the market price for post-consumer magazine will have the effect of encouraging collection and processing efforts on the part of municipalities, especially if market prices can readily be demonstrated to exceed unit costs of processing, exclusive of the estimated long run marginal cost of landfill (See Halton Region's draft report on the use of post-consumer magazines in newsprint manufacture, submitted to MOE Waste Management Branch, Fall 1990.) It is anticipated that the market value of post-consumer magazine will increase with increases in ONP demand for newsprint manufacture.

7.3 *Assessment of Market Capacity to Absorb Supply*

According to magazine utilization projections provided in this section for various mills in the province, a total of 282,000 tonnes of magazines will be required to fill demand by 1991 (138,000 tonnes in Ontario mills alone). Projected diversion in 1992 is only expected to amount to five per cent of this demand or 14,100 tonnes, and in 2000 less than 20% of demand will be recovered. Thus, available supplies could be easily absorbed by local demand.

As with other materials described in this report, there is a strong possibility that Ontario mills requiring magazine stock for their processes will secure some of this supply from U.S. sources in addition to purchasing local materials. U.S. sources are often able to offer large quantities and reciprocal agreements. To ensure that U.S. OMG does not displace Ontario OMG, Ontario could take the lead in improving the supply of old magazine stock by implementing wide-spread household curbside collection of this material.

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8.0 TELEPHONE DIRECTORIES

8.1 Supply

8.1.1 Generation by Sector

Current Generation

Bell Canada statistics indicate that 20,300 tonnes of phone books were shipped to Ontario households and businesses in 1989. These books became waste in 1990. CH_2M Hill data indicate that 13,000 tonnes of phone directories were generated as waste in the residential waste stream. The remainder, 7,300 tonnes is therefore in the ICI waste stream.

Projected Generation

Based on average 1989 household consumption, growth in population alone will increase the weight of phone books in the residential waste stream to 13,570 tonnes in 1992 and 14,750 tonnes in 2000. Similarly, phone directories in the ICI sector, assuming they maintain their 36% share of this waste stream, are estimated to be 7,620 tonnes and 8,285 tonnes in 2000.

8.1.2 Current and Projected Diversion Levels

Current Diversion

Recovery figures presented are based on telephone directory collection programs operating in the province. Currently, three curbside collection programs are collecting telephone books, including Guelph, Mississauga and North York.

These programs are all relatively new, with little collection data. In order to estimate 1989 recovery data for these programs, RIS assumed that a 60% recovery rate would be achieved for all households serviced. Bell Canada, in tandem with Tele-direct (yellow pages) has been working aggressively with several municipal programs to recover and recycle books. It is expected that this will continue. Thus, 1989 recovery is estimated at:

- 48 tonnes for Guelph
- 205 tonnes for Mississauga
- 497 tonnes for North York

Thus, total diversion in 1989 is estimated at 750 tonnes.

Projected Diversion

The majority of telephone directory waste is generated in Ontario by householders (64%), while the remainder (36%) is generated by private businesses as discussed in section 8.1.1.

Assuming that Bell's efforts on recycling continue, RIS estimates that the number of curbside programs offering collection of telephone directories will increase over the projection period. However, the lack of available North American markets will likely limit the number of municipalities that can offer collection to residents. Telephone books are mostly sold overseas.

Bell is currently experimenting with changes to Ontario telephone directories. The 1990 books are made from a lighter weight paper stock, which will reduce the total quantity of telephone directory waste generated in Ontario by 11% in 1991. No volume reductions are likely for the cover stock used on these books. Thus, reduction in generation in the study period will be 1,950 tonnes in 1992 and 2,134 tonnes in 2000. These are reflected in the figures in table 8.1.

RIS estimates that by the year 1992, approximately 20% of blue box households will have telephone book collection. It is likely that recovery from these programs will approach 60%, amounting to a provincial diversion of 1,185 tonnes (2.9 million hhlds x 60% x 20% x 3.4 kg/hhld). By the year 2000, it is likely that 60% of blue box households will have telephone book collection. With increased program promotion, it is likely that recovery would approach 70%. The resultant provincial diversion would be 5,000 tonnes (3.5 million hhlds x 70% x 60% x 3.4 kg/hhld).

Bell is also experimenting with biodegradable inks and bindings which will make recycling easier for mills.

In the ICI sector, pro-rating lightweighting efforts is expected to result in 685 tonnes diverted in 1992 and 745 tonnes by 2000. Recycling could increase these levels, but have not been estimated.

Table 8.1 summarizes telephone book generation and diversion estimates.

Table 8.1
Telephone Book Generation and Diversion Estimates for Ontario
(tonnes/year)

	1989	1992	2000
Residential Generation	13,000	13,570	14,750
Residential Diversion	750	2,435	6,365
ICI Generation	7,300	7,620	8,285
ICI Diversion	N/A	685	745

Note: diversion includes diversion through lightweighting

8.1.3 Potential for Increased 3R's Activity

Reduction

Reduction opportunities include generating computer disk copies of telephone directories, and making them available to large businesses which would typically require many telephone directories. This strategy could substantially decrease the generation of waste directories by the ICI sector.

Recycling

In the past, telephone directories have not been utilized as a feedstock by Canadian paper mills because of contamination due to glues, bindings and colour and cover variations. Recently, Bell Canada has committed to improving the recyclability of both the white and yellow pages.

These changes mean that the books can potentially be more easily recycled. However, markets for this material are weak and underdeveloped. In order to increase the volumes of telephone books recycled in the province, market development will be required.

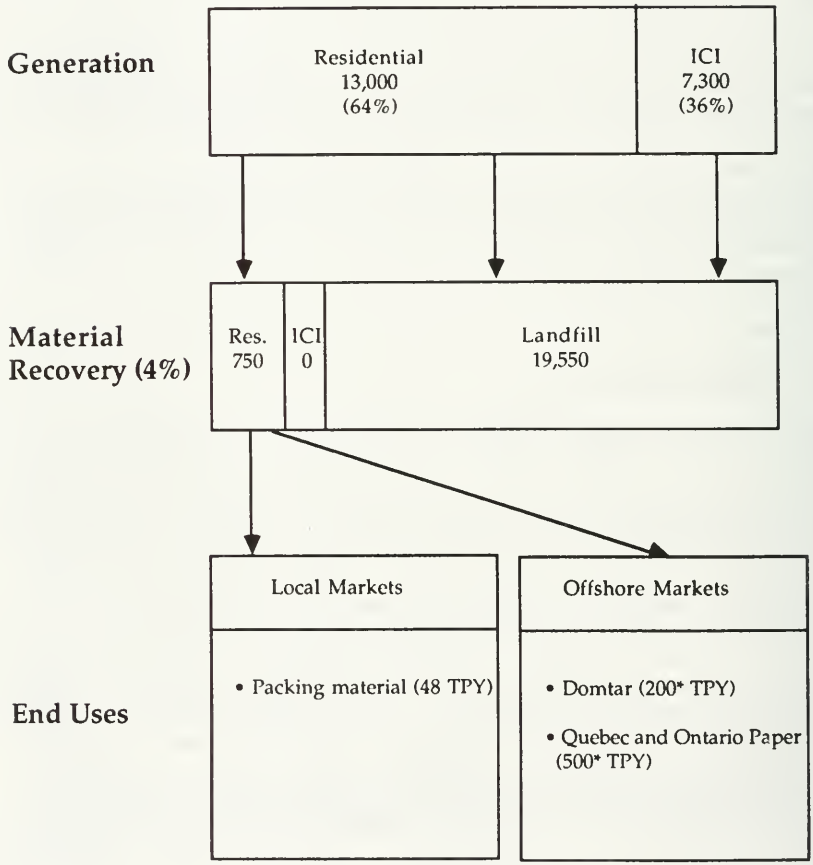
8.2 Demand

8.2.1 Market Structure

Telephone directories have been sporadically used in the production of corrugated medium, in Asia. As part of mixed grade fibre it has been used for construction materials, roofing felts, chipboard and insulation. A few mills have tested directories for use in newsprint and sanitary products. These tests have revealed difficulties in processing due to book bindings and contamination from hot melt glues, and inks. Phone books are a low quality material to begin with, and these processing issues add to the problems.

A limited number of phone books are collected in Ontario. Three municipalities collect residential phone books and a number of large businesses and institutions are having their directories collected annually for recycling purposes. Phone books collected in Ontario have been brokered by Quebec and Ontario Paper and Domtar to overseas markets.[1] Taiwan is a popular destination for this fibre where it is manufactured into sanitary tissue and corrugated cardboard. A small portion of Guelph's books are being used by a local transportation company as packing material.[2] (Refer to Figure 8.1 for a summary of local markets for telephone books).

Figure 8.1
Telephone Books (tonnes per year)
Ontario 1989



*RIS estimates

8.2.2 Factors That Influence Demand

Ontario demand for phone books is virtually non-existent. There are two reasons which may account for this market situation:

- the low cost and availability of ONP,
- the weakness of the export market,
- contaminants, principally glue, in the books.

With high transportation costs and low market prices, it is not economically viable to export this low-value product. In terms of the near future, the market price is not expected to rise until the price of ONP begins to rise.[3]

The demand for phone books is directly related to the demand for other low grade fibres such as ONP, magazines and mixed paper. Since there has been a glut of ONP in recent years, the demand for phone books is extremely low.

As with magazines, telephone books have a number of technical barriers to their recyclability. These barriers make them a relatively undesirable fibre on today's market. Overcoming these barriers will increase the number of potential end users of phone books. Because of their short fibres and mix of paper grades (the cover is generally a different grade than the contents), phone books are considered a lower grade of fibre than ONP.[4] The hot melt glue found in the bindings of phone books is a problem for some recyclers, although Bell is researching more recycling friendly bindings, inks etc. Cascades in Quebec uses telephone books as part of their feedstock in the manufacture of sanitary tissue, hand towelling, industrial wipes, napkins, placemats and other products of a commercial grade.[5]

Bell is also researching alternate markets for directories including animal bedding and fibreboard. The research has not yet yielded sufficient results to allow us to estimate with confidence the market demand for used directories.[6]

8.2.3 Factors That Influence Choice Between Primary and Secondary Materials

The value of telephone books is in the fibre. However, until they can be accepted more readily in the paper making process virgin and other secondary fibres will have preference over that in used directories.

It is estimated that even if ONP was to increase in price substantially, causing some mills to look for lower grade substitutes, it is likely that mixed paper would be favoured over telephone books. Mixed paper is perceived as being

much less labour intensive to use than telephone books that require the removal of bindings.

8.2.4 Price/Elasticity Analysis

In North America, waste telephone directories can be used as inputs to the same manufacturing processes as OCC, mixed paper and, to a lesser extent, ONP, boxboard, corrugating medium and construction materials. In East Asia, old telephone books are used to make sanitary tissue and construction materials. New local uses, such as animal bedding, are being explored. In general, the restricted demand and relatively new markets (domestic and abroad) for this commodity militate against gathering data pertinent to the estimation of price elasticities. No economic literature was found on the subject of old telephone directories.

Elasticity of Demand Issues

Nearly all of the telephone directories collected each year in Ontario are sold to foreign buyers. Canadian consumers of secondary fibres prefer cleaner substitutes like ONP or OCC. A number of paper mills in the U.S. use this type of waste paper despite its negative attributes: hot melt spine glues, quantity of ink per unit weight, yellow dye (in Yellow Pages), and cover material made of different stock. The explanation for this may lie in technological differences between the various plants. (See discussion in previous section). In some cases, telephone books are a substitute for any other low grade waste paper. Their price is expected to track the average price of substitute waste paper categories.

Elasticity of Supply Issues

In 1989, 20,300 tonnes of telephone directories were discarded into the waste stream in Ontario. Very little collection is undertaken for recycling purposes. At present, there are three municipalities engaged in old telephone books seems to depend on the cooperation of telephone utilities. In Wisconsin, for example, an arrangement has recently been made between Fort Howard Paper Co. and Southwestern Bell to collect old telephone directories for use in making tissue and towelling. The motive for the telephone company involvement stems from the public perception that telephone books should not be discarded after their relatively short lifespan. The paper manufacturer can take advantage of such an arrangement to obtain with relative ease an assured supply of waste paper of known quality.

8.3 *Assessment of Market Capacity to Absorb Supply*

The current use of telephone books as a secondary fibre is modest. However, Bell Canada and its subsidiary, Tele-direct, are aggressively pursuing market development opportunities. In the interim, few recycling programs target telephone books for collection and therefore, there is not a glut of available material on the market, as is currently the case with ONP. If phone books were aggressively collected in North America as part of a recycling program, it is unlikely the current or near-future demand could absorb this material although the market development needs to be monitored in order to bring supply on stream when demand begins to increase.

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9.0 PLASTICS

9.1 Supply

Plastics currently comprise 7% of the municipal solid waste stream (MSW)[1] according to the society of the Plastics Industry in Canada (SPI). By the year 2000 they are expected to increase to 9.8% of MSW, primarily as plastics continue to displace glass containers and other packaging materials.

Plastics are an even larger component of the waste stream by volume, comprising 18% of MSW[2]. Consumers tend to perceive plastics packaging as less environmentally friendly because most plastics are not biodegradable and are made from non renewable resources. A public opinion poll conducted for The Environmental Report[3] reports that 42% of consumers polled cited plastics packaging as being environmentally harmful. By comparison, only 14% of consumers polled thought that metal packaging was environmentally harmful and only 8% had concerns with respect to the environmental impacts of glass packaging.

While the recycling infrastructure for glass as well as metal packaging is well established, plastics recycling is still in its infancy. Plastic products are made from many different resins[4] which means they are not a homogeneous product. These resins are different in chemistry and are often not compatible to be mixed in the recycling process. Recycling is further complicated by the fact that within any product group (e.g. water bottles) manufacturers use different types of resins. The exception is the polyethylene terephthalate (PET) soft drink bottle which has a 100% share of the plastic soft drink bottle market.

These factors make it difficult to target resin types at the municipal level since householders cannot easily distinguish plastic resins from one another. Although increasing numbers of plastic containers now display the SPI recycling code[5] which categorizes plastics into 7 groups based on their chemistry the use of this code is not universal. Therefore, it is virtually impossible for a consumer to visually distinguish between a PET and PVC bottle.

The plastics industry is under increasing pressure to recycle its material. Mechanical or electronic technologies for sorting plastics into their component resin groups are not yet available to recycling operators: thus while plastics in the municipal solid waste stream could be recovered, recycling is very costly and remains a challenge.

It is, however, necessary to identify plastic product groups that should be targeted for recovery over the next 10 years in order to make significant inroads to the reduction of plastics in the waste stream.

Because of their high visibility, the focus for plastics recycling to date has been on rigid plastic containers - most notably, plastic bottles. In addition, it is expected that increasing pressure will be placed on the plastics industry to recycle plastic films given their widespread use in the residential as well as industrial/commercial/institutional (ICI) waste streams as shown in Table 9.1.

Therefore, this section focuses on the recovery of rigid plastic containers and plastic films to the year 2000.

Rigid plastic containers (RPC) refer to plastic bottles and jugs used to package the following products:

- **Food and Beverages** (e.g. soft drink, squeezable ketchup, milk jugs, and yogurt, etc.);
- **Household Cleaners/Detergents** (dish detergents, window cleaning products, etc.);
- **Personal Care Products** (e.g. shampoo, mouthwash, etc.);
- **Automotive Products** (e.g. motor oil, window washer fluid, etc.);
- **Other Products** (e.g. arts and crafts products such as paints, etc.).

Film plastics include plastic bags and wraps (e.g. grocery bags, dry cleaning bags, pallet wraps, food wraps, etc.).

9.1.1 Generation By Sector

Current Generation

The following section of the report highlights the generation of RPCs and plastic film in Ontario for 1989.

In the case of RPCs, PET and high density polyethylene (HDPE) generation rates are also highlighted, as these resins currently account for most of the post-consumer plastics being recycled.

Table 9.1 summarizes the generation and recovery of RPCs and plastic film for 1989.

1989

- according to CH2M Hill, there were 252,200 tonnes of plastic in the residential waste stream (RSW) and 163,080 tonnes of plastic in the industrial/commercial/institutional (ICI) stream for a total of 415,000 tonnes of plastic in the waste stream;

- 36,340 tonnes of RPCs were generated in the RSW stream and 45,340 tonnes were generated in the ICI stream for a total of 81,680 tonnes of RPCs or 19.7% of the total plastics generated[6];

- PET RPCs accounted for a 3,540 tonnes in the RSW stream[7] and 390 tonnes in the ICI stream for a total of 3,930 tonnes;

- HDPE RPCs comprised 17,440 tonnes of material in the RSW stream and 21,770 in the ICI stream for a total of 39,210 tonnes[8];

- there were 101,260 tonnes of plastic film generated in the RSW stream and 56,960 tonnes of films generated in the ICI stream for a total of 158,220 tonnes or 38% of total plastics generated[9].

Projected Generation

The following section projects the generation of RPC's and plastic film in Ontario for 1992 and 2000. Table 9.1 summarizes these projections.

1992

- based on SPI estimates plastics generation is expected to increases at an annual rate of 7% between 1989 and 1991 and 6.3% between 1991-1992, there will be a total of 505,067 tonnes of plastic in the waste stream in the year 1992;

- 47,060 tonnes of RPCs are projected in the RSW stream and 58,100 are projected in the ICI stream for a total of 105,160 tonnes or 20.8% of total plastics generated[10];

- PET RPCs are estimated to be 4,420 tonnes in the RSW stream and 490 tonnes in the ICI stream for a total of 4,910 tonnes;

- HDPE RPCs are estimated to be 22,600 tonnes in the RSW stream and 27,890 in the ICI stream for a total of 50,490 tonnes;

- 116,020 tonnes of plastic film are projected for the RSW stream and 65,260 are projected for the ICI stream for a total of 181,280 tonnes or 35.8% of total plastics.

2000

- assuming that plastics production increases at an annual rate of 6.3% between 1992 and 2000 (SPI estimate for 1991-1996 projected to 2000), there will be a total of 829,656 tonnes of plastic in the waste stream in the year 2000;

- 93,770 tonnes of RPCs are projected for the RSW stream and 102,520 are projected for the ICI stream for a total of 196,290 tonnes or 23.6% of total plastics generated;

- PET RPCs are estimated to be 7,840 tonnes in the RSW stream and 870 tonnes in the ICI stream for a total of 8,710 tonnes;

- HDPE RPCs are estimated to be 45,010 tonnes in the RSW stream and 49,210 in the ICI stream for a total of 94,220 tonnes;

- 177,380 tonnes of plastic film are projected for the RSW stream and 99,780 are projected for the ICI stream for a total of 277,160 tonnes or 33.4% of total plastics generated.

9.1.2 Current and Projected Diversion Levels

Current Diversion

1989

In 1989 a total of 1,030 tonnes of RPCs and film were recycled in Ontario representing .4% of total plastics generated[11].

A total of 980 tonnes of RPCs were recycled from Ontario blue box programs representing 2.7% of RPCs generated.[12] Of this total, 470 tonnes were PET soft drink bottles and 460 were HDPE containers. The remaining 50 tonnes were a mix of primarily polystyrene (PS), polypropylene (PP), and polyvinylchloride (PVC) containers that were sent to Superwood in Mississauga (see section 9.2).

Only an estimated 50 tonnes of film were recycled, all from Mississauga's mixed plastics program for processing at Superwood.

Projected Diversion

1992

The projected recovery of RPCs and plastic films for 1992 are based on the following assumptions:

- 50% of Ontario households will have mixed RPCs collected in their blue boxes and 35% of RPCs generated in the residential sector will be recycled;

- 100% of Ontario households will have PET collected in their blue boxes, either through PET-only programs or through mixed RPC collection programs with 40% of PET bottles being recycled;

- 20% of RPCs generated in the ICI sector will be recovered through an expansion of municipal recyclables collection into the ICI sector and/or an expansion of private haulers collecting recyclable material from ICI establishments;

- 1,000,000 blue box households will recycle an average of 10 pounds of plastic film bags per year in Ontario. This is primarily based on Metro Toronto's intention to recycle film bags when its new processing facility comes on stream in 1992 plus continuation of film plastics recycling in Mississauga, Grand Bend, Markham, and Lindsay.

Based on the above assumptions, the following recovery rates are projected for 1992:

- a total of 19,860 tonnes of RPCs and 450 tonnes of plastic film will be recycled representing 4% of total plastics generated (20,310/505,067)[13];

- 8,240 tonnes of RPCs are projected to be diverted from RSW and 11,620 tonnes are projected to be diverted from ICI. This equates to a recovery rate of 18.9 of total RPCs in 1992;

Table 9.1. Summary of Plastics Generation and Diversion 1989, 1992, 2000 (tonnes)

	1989 Generation			1989 Diversion					
	RSW	ICI	Total	RSW	% of RSW Generated	ICI	% of ICI Generated	Total	% of Total Generated
All Rigid Plastic Containers (RPCs)	36,340	45,340	81,680	980	2.7%	0	0.0%	980	1.2%
Film	101,260	56,960	158,220	50	0.0%	0	0.0%	50	0.0%
Total	137,600	102,300	239,900	1,030	0.7%	0	0.0%	1,030	0.4%
PET RPCs	3,540	390	3,930	470	13.3%	0	0.0%	470	12.0%
HDPE RPCs	17,440	21,770	39,210	460	2.6%	0	0.0%	460	1.2%
Total PET & HDPE RPCs	20,980	22,160	43,140	930	4.4%	0	0.0%	930	2.2%
PET & HDPE RPCs % of All RPCs	57.7%	48.9%	52.8%	94.9%		0.0%	0.0%	94.9%	

	1992 Generation			1992 Diversion					
	RSW	ICI	Total	RSW	% of RSW Generated	ICI	% of ICI Generated	Total	% of Total Generated
All Rigid Plastic Containers (RPCs)	47,060	58,100	105,160	8,240	17.5%	11,620	20.0%	19,860	18.9%
Film	116,020	65,260	181,280	450	0.4%	N/A		450	0.2%
Total	163,080	123,360	286,440	8,690	5.3%	11,620	9.4%	20,310	7.1%
PET RPCs	4,420	490	4,910	1,780	40.3%	100	20.4%	1,880	38.3%
HDPE RPCs	22,600	27,890	50,490	3,950	17.5%	5,580	20.0%	9,530	18.9%
Total PET & HDPE RPCs	27,020	28,380	55,400	5,730	21.2%	5,680	20.0%	11,410	20.6%
PET & HDPE RPCs % of All RPCs	57.4%	48.8%	52.7%	69.5%		48.9%		57.5%	

	2000 Generation			2000 Diversion					
	RSW	ICI	Total	RSW	% of RSW Generated	ICI	% of ICI Generated	Total	% of Total Generated
All Rigid Plastic Containers (RPCs)	93,770	102,520	196,290	37,500	40.0%	30,700	29.9%	68,200	34.7%
Film	177,380	99,780	277,160	26,600	15.0%	15,000	15.0%	41,600	15.0%
Total	271,150	202,300	473,450	64,100	23.6%	45,700	22.6%	109,800	23.2%
PET RPCs	7,840	870	8,710	6,100	77.8%	260	29.9%	6,360	73.0%
HDPE RPCs	45,010	49,210	94,220	18,000	40.0%	14,800	30.1%	32,800	34.8%
Total PET & HDPE RPCs	52,850	50,080	102,930	24,100	45.6%	15,060	30.1%	39,160	38.0%
PET & HDPE RPCs % of All RPCs	56.4%	48.8%	52.4%	64.3%		49.1%		57.4%	

Note: RSW is residential solid waste; ICI is industrial, commercial, institutional solid waste

Source: Data compiled by RIS through discussions with plastics industry officials (see Section 9.4 for references)

- 450 tonnes of plastic film are projected to be diverted through blue box programs. (Data on current or projected film recycling in the ICI sector are not presently available. A survey recently completed by RIS for ICI based industries indicates that more basic information on plastic film recycling is needed by industry to direct future activities in this area. Due to the lack of available data, RIS has been unable to estimate the recovery of plastic film from the ICI sector in 1992.);

- 1,780 tonnes of PET RPCs and 3,950 tonnes of HDPE RPCs will be recovered from the residential sector for a total of 5,730 tonnes or 70% of RPCs. The remaining RPCs will be comprised primarily of a mix of PS, PP, and PVC.

While all RPCs are all technically recyclable, they will be recycled only if they are separated into resin groups and shipped to appropriate recycling markets (or sent to mixed plastics processors such as Superwood.) Currently demand is highest for used PET and HDPE bottles which sell for approximately 10 cents per pound in the northeast U.S. as compared to mixed rigid containers which sell for about 4-5 cents per pound.[14];

- of the 11,620 tonnes of RPCs that will be recovered from the ICI sector approximately 50% will be HDPE. The remaining RPCs from the ICI sector will be recycled only if they are sent to appropriate end markets.

2000

The projected recovery of RPCs and plastic films for 2000 is based on the following assumptions:

- 100% of Ontario households will have mixed RPCs collected in their blue boxes and 40% of RPCs generated in the residential sector will be recycled;

- 30% of RPCs generated in the ICI sector will be recovered;

- 15% of plastic films from both the residential and ICI sectors will be recycled (based on the emergence of collection and sorting technologies, and market opportunities for the material);

Based on the above assumptions, the following recovery rates are projected for 2000:

- a total of 109,800 tonnes of RPCs and plastic film will be recycled representing 13.2% of total plastics generated;

- 37,500 tonnes of RPCs are projected to be recovered from the residential sector and 30,700 tonnes are projected through diversion from ICI for a total of 68,200 tonnes of RPCs. This equates to a recovery rate of 34.7% of total RPCs in 2000;

- 6,100 tonnes of PET RPCs and 18,000 tonnes of HDPE RPCs will be recovered from the residential sector for a total of 24,100 tonnes or 64% of RPCs;

- 30,700 tonnes of RPCs will be recovered from the ICI sector of which almost 50% will be HDPE;

- 26,600 tonnes of film from the residential sector will be recycled and 15,000 tonnes will be recycled from the ICI sector using 15% of total films generated as a rough estimate.[15]

9.1.3 Potential for Increased 3R's Activity

As the above analysis indicates, given current trends only a relatively small percentage of plastics generated are likely to be diverted from the waste stream through to the year 2000. The following section of the report discusses the potential for further reduction, reuse, and recycling of plastics to attain increased diversion levels.

Reduction

In the absence of strong government action or concerted and possibly collective efforts by major users of plastics packaging, it is unlikely that overall reduction in plastics will occur. As plastics continue to displace other packaging materials (e.g. glass bottles, corrugated boxes, etc.), and as new plastic products enter the market, the overall percentage of plastics in MSW may increase.

Some reduction activities are already occuring in the marketplace. For example, Procter and Gamble's introduction of the "Enviro-Pack" results in a 70% weight reduction where the refill is purchased instead of a new bottle, and the company is researching methods of recycling this package which is made of 2 basic plastics.

In addition, to minimize costs, companies are using new lighter weight materials for their products. Because "lightweighting" usually results in

material reduction, there is a positive environmental impact of waste generation.

However, it is unlikely that reduction, in itself, will play a significant role in waste diversion.

Reuse

Reuse of plastics can occur on two levels: informal and wide scale. Certain plastic products have always been reused by industry and householders. For example, industries reuse plastic pails and householders reuse food tubs. This type of reuse is essentially informal: that is, it does not rely on a formal infrastructure for collecting, cleaning and refilling the product.

Wide scale reuse, on the other hand, refers to systems where containers are collected, cleaned, and refilled. The current deposit system for glass beer bottles in Ontario is an example of a wide scale reuse system.

Similar reuse of plastic bottles is currently problematic because plastics, unlike glass, may absorb a portion of the material that they contain. It is difficult to identify contaminants or remove them from the material. This is especially dangerous when, for example, a homeowner uses an empty food bottle to store a hazardous substance prior to putting the bottle back into the reuse system. Potential for contamination was one reason why plastic milk jugs were phased out.

However, technologies are being developed to identify and remove contaminants from plastics. The successful application of these technologies are expected to pave the way for increased plastics reuse activities.

The first likely application of wide scale plastic container reuse will likely be a refillable PET soft drink bottle which is being tested in Europe.

Recycling

The inclusion of RPCs and, ultimately, plastic film into curbside recycling programs offers the best prospect for diverting significant amounts of plastics from the waste stream.

However, wide scale curbside collection of plastics is by no means assured given the following barriers that currently exist:

- while stable (and growing) markets exist for PET and HDPE bottles there are limited markets for other product applications (e.g. food tubs) or other resin groups (LDPE, PP, PS, PVC);

- PET and HDPE reprocessors (as indicated in section 9.2) usually require homogeneous bales of plastic bottles. However, there is currently no viable system for mechanically sorting mixed plastics into component resin groups. Manual sorting of resins at the material recovery facility (MRF) usually separates only PET soft drink bottles and containers that can readily identified as HDPE (milk jugs, bleach bottles). Containers that can not be easily identified are usually landfilled;

- although some markets accept mixed plastic bottles,[16] the price paid is minimal (0-5 cents/lb). However, because plastic containers have such a high weight to volume ratio, they are expensive to collect and transport. Therefore, blue box program operators may find little financial incentive to collect plastics;

- the barriers to RPC collection are, in many respects, minor compared to problems associated with the collection and sorting of plastic film. There are virtually no markets for mixed film and there are no viable methods for mechanically sorting of the material.

The current barriers to RPC and plastic film recycling need to be overcome before plastics recycling can play a key role in terms of diverting available material from landfill as measured by the 50% objective for NAPP in 1992.

Section 19.3 of the report provides comments to the Ministry of the Environment on the role that the Ministry can play in helping to overcome these barriers.

9.2 Demand

9.2.1 Market Structure

The recycling industry for post-consumer and post-industrial plastics is still in its early stages of development. While strong demand exists for PET and HDPE bottles, markets for other resins such as PVC, PP, and PS as well as mixed plastics are not yet established. As stated earlier, markets for used plastic film are virtually non-existent.

The following section of the report describes the current market for used plastics.

PET Bottles

All Ontario curbside recycling programs, with the lone exception of Ottawa, currently collect PET soft drink bottles. In 1989, 3,542 tonnes of PET bottles consumed in Ontario's of which 473 tonnes were recovered through curbside programs.[17]

Twinpak subsidizes the collection of all PET bottles in Ontario. They currently pay $0.15/lb. for full truckloads of baled PET (i.e. 30,000+ lbs.) and $0.10/lb. for anything less than a full load.[18] Twinpak's objective is to provide an incentive to ensure that sufficient quantities of PET bottles are being recycled to meet the soft drink container legislative regulations[19].

Twinpak sells the PET to either Wellman, Inc. (Shrewsbury, N.J) or Day Products (Bridgeport, N.J.). At the time of drafting this report (September 1990), Twinpak was dealing with Day Products on the "spot market". Twinpak will not divulge the price they are paid by Day Products for the material. However, information obtained through Day Products indicated that in July 1990 they were paying 6-10 cents/lb. for PET.[20] (Modern Plastics, July 1990 issue, reports the average price paid for PET at a slightly higher 11-13 cents/lb.). Twinpak will also pay between 33-100% of the cost of shipping the PET bottles to market depending on the size of the load[21]. Therefore, Twinpak is selling PET to Day Products at a loss of between 2-5 cents/lb. excluding transportation costs.

Day Products currently process 18,000 tonnes of PET annually, of which 5% comes from Ontario. Day's New Jersey plant is being expanded to process 27,000 tonnes of PET per year.

Day sells the reprocessed PET to a variety of end users including textile and bottle (non-food) manufacturers, as well as engineering resin companies which manufacture products such as car parts, toys, etc. (Figure 9.1 provides a list of end uses for post-consumer rigid plastics.) Recycled PET is sold to end users for approximately $0.40/lb, which is about 2/3 the cost of virgin resin[22].

The other major market for Ontario PET bottles is Wellman, Inc. in Johnsonville, South Carolina. The company has a capacity to process 90,000 tonnes of PET per year. Wellman Inc. pays market price for used PET bottles (10 cents per pound in the first quarter of 1990).

HDPE Bottles

Unlike the U.S. where milk bottles are made from HDPE, there is not one product line in Canada that is uniquely packaged in this material. Therefore, there are no 'HDPE collection' programs in Canada targeted to collect this

plastic which is second in value to PET. Where it is collected at curbside, HDPE is always one component of a mixed plastics program.[23]

According to OMMRI, six Ontario municipalities collected HDPE as part of a 'mixed plastics' program during 1989. In total, an estimated 457 tonnes of HDPE bottles were recovered, separated and sold through curbside collection programs in that year.

The market structure for post-consumer HDPE bottles is embrionic with new players, such as Brantford-based Resource Plastics coming on stream and various alliances between collectors, reprocessors, and end users being formed as well as discontinued. According to SPI, several major resin producers are actively exploring options to collect, sort and reprocess plastics.

Dow/Domtar

An alliance was formed between Dow Chemical and Domtar Packaging in 1989 to reprocess HDPE. HDPE bottles from Guelph and Bluewater Recycling in Sarnia were sold to Dow/Domtar in that year. However, the technology for separating the plastic resins proved to be non-viable and the venture was terminated in the spring of 1990. Programs previously sending their plastics to Dow/Domtar are seeking alternate markets.

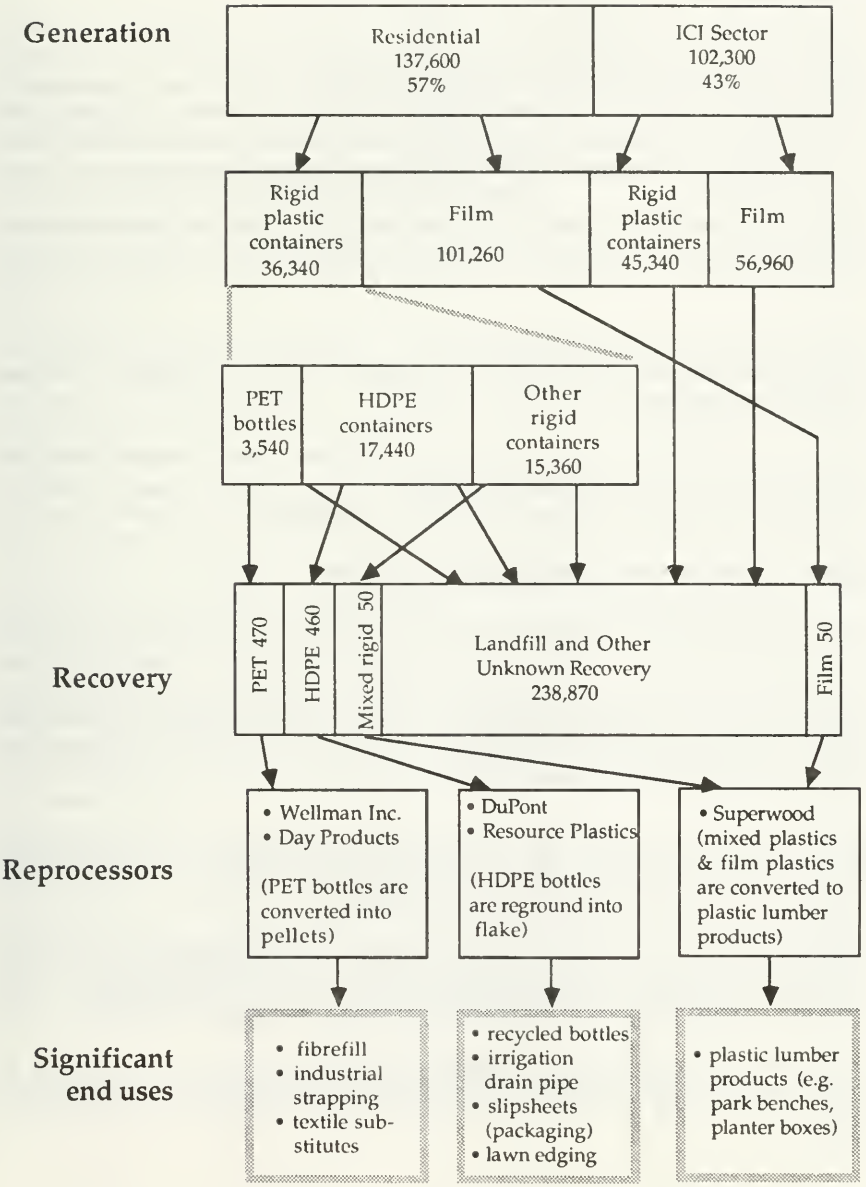
Plastics Recycling Alliance (Du Pont/WMI)

The Plastics Recycling Alliance (PRA) is a joint venture of Du Pont and Waste Management Inc. Du Pont has entered into an arrangement with Procter and Gamble as well as Plax a plastic bottle manufacture. HDPE bottles collected in Ontario will be sent to Plax to be made into new bottles containing 25% reprocessed material. These bottles will be used by Procter and Gamble to market non-food products such as detergents. The longer term objective is to increase the recycled content to 50%. PRA reports a capacity at each of their Chicago and Philadelphia plants to process 18,180 tonnes of HDPE. This capacity is expected to increase to 72,700 tonnes/yr. by 1994 with the addition of three new U.S. facilities.

Figure 9.1 (overleaf) provides a summary of Ontario generation recovery and markets for secondary plastics.

The following are the current markets for post-consumer HDPE bottles collected in Ontario.

Figure 9.1
Plastics (tonnes per year)
Ontario 1989



The City of Toronto markets its HDPE to PRA in Philadelphia. PRA has also indicated that it will build a facility in Ontario to reprocess plastics when quantities warrant.

Resource Plastics

Resource Plastics is a plastics reprocessing operation based in Brampton, Ontario. It was founded in 1989 and during most of its first year of operations the company processed only industrial plastic scrap. However, beginning in the early spring of 1990, the company began to process post-consumer HDPE from blue boxes. Resource Plastics has determined that reprocessing post-consumer HDPE can be a profitable venture while also providing an opportunity for Ontario-generated post-consumer HDPE to continue to be recycled within the province given the demise of the Dow/Domtar venture[24].

Resource Plastics is now negotiating with a number of Ontario programs collecting 'mixed plastics' in order to establish itself as the primary Ontario mixed plastics market.

Resource Plastics' existing plant can process approximately 3,400 tonnes of rigid HDPE as well as polyethylene film. The company plans to build a second plant also with an annual capacity of 3,400 tonnes.

A Case Study of HDPE Reprocessing Economics[25]

The price paid to recycling program operators for baled HDPE is dependent on the end use of the reprocessed material and specifically on the quality and homogeneity of the bale. High-end uses such as reprocessing the HDPE into new bottles commands the highest price -- 7.5-9 cents/lb. depending on freight costs. (At the other end of the spectrum, mixed plastics bales containing as much as 70% HDPE may derive no revenue).

Operating costs for a facility like Resource Plastics is estimated at about $0.17/lb (including $0.06/lb. for manually sorting the HDPE from other plastic bottles included in the baled blue box material)[26].

Resource Plastics expects that the reground HDPE will obtain revenues of $0.39 from reprocessors using the material in new bottle applications. This could net Resource Plastics a $0.13/lb in revenues, excluding overhead.

It should be noted that the above figures are estimates. Because the facility is not yet processing post-consumer HDPE at full capacity, all costs cannot be anticipated.

Mixed Plastics

Superwood (Mississauga)

Superwood Ontario Limited (Mississauga) is presenting itself as one possible answer to the plastics sorting problem. The Superwood technology can process mixed rigid and film plastics into a plastic lumber substitute. Superwood receives its post-consumer plastic feedstock from Mississauga's mixed plastic collection program. Residents of the city can place any household plastic product in or beside their blue box. Superwood also accepts Tetra Pak asceptic packaging from a pilot collection program in Markham.

Superwood's Mississauga plant is currently processing 3,180 tonnes of mixed plastics per year running at 100% capacity. The plant's capacity is expected to increase to 4,760 tonnes by the end of 1991 with the addition of new machinery.[27]

Superwood's process requires that approximately 60% of the feedstock be low and high density polyethylene. Therefore, residual bottles that remain from mixed plastic bottle collection programs once the PET and HDPE have been sold will still need alternate markets.

The main concern with the Superwood technology is whether markets exist for the plastic lumber. Because of production costs, plastic lumber is more expensive than pressure treated lumber and is, therefore, not expected to be an "everyday" substitute. Its current product markets are limited to park benches, tree enclosures, docks, etc. In order to be viable in the long term, Superwood will need to establish additional markets for the product.

Furthermore, companies like Du Pont and Resource Plastics can afford to pay more for their feedstock than can Superwood because their end products (e.g. recycled plastic bottles) command a higher price and represent more secure long-term markets.

While Resource Plastics will pay 7.5 cents/lb. (FOB seller's dock) for mixed plastics, plastic lumber manufacturers pay in the range of 0-3 cents/lb. In a market where there is strong demand for post-consumer plastics, Superwood may have trouble competing for post-consumer plastics on the basis of price paid. This factor may become even more significant should mechanical sorting technologies come on stream making it easier to separate the various resins and market them to reprocessors for higher end use applications.

To summarize, it is likely that Superwood will play a limited overall role in the plastics recycling arena in Ontario.

Emerging Plastics Markets

Both the foam polystyrene and polyvinylchloride industries are initiating pilot recycling programs in Canada and the U.S. Both of these groups are especially vulnerable to legislation/bans given that these resins are not compatible with either PET or HDPE in the recycling process. For example, PVC has a different melt temperature than PET and may form hydrochloric acid when inadvertently included in a PET recycling system.

Therefore, these industries are beginning to investigate the feasibility of recycling their products through the following ventures:

Canadian Polystyrene Recycling Association

This association is establishing a plant in the Toronto area capable of initially recycling 6,000 tonnes of single use polystyrene per year from restaurants and fast-food packaging applications. This represents about 10% of the estimated 59,000 tonnes of polystyrene consumed in Ontario in 1990.[28] Targeted products include hot food containers, take-out coffee cups, plastic cutlery, foam meat trays, egg cartons and used packaging materials. The association plans to increase this capacity to 45,000 tonnes annually by the year 2000. The association is also examining options for collecting and consolidating the material and is also evaluating alternative sites for the facility.

Under the plan, the polystyrene will be washed, extruded into strands and pelletized at a cost estimated at 40-50 cents/lb.

Polyvinylchloride Recycling

Occidental Chemical and Georgia Gulf in the U.S. have announced that they will recycle PVC bottles. This is in large part in response to the environmental pressure being brought to bear on this resin. H.A. Heller and Co. Inc. have announced that they will broker PVC to Georgia Gulf.

In terms of overall waste diversion potential, PVC recycling will have a negligible effect as only 9% of bottles are made from PVC. Although PET bottles account for only a slightly higher percentage of bottles, it has the advantage of having 100% of the plastic soft drink bottle market and is, therefore, highly recognizable. However, manual sorting of PVC bottles is not as straightforward given the absence of a distinct product line.

9.2.2 Factors that Influence Demand

Market Development

Plastic packaging is often targeted as a symbol of our throwaway society. It is, therefore, vulnerable to various forms of legislation including bans. The decision to allow PET soft drink bottles in Ontario was, in fact, linked to the requirement that 50% of the bottles be recycled.

Therefore, the industry views recycling market development as an important investment. For this reason, a company like Twinpak is subsidizing the recycling of PET bottles, with the expectation that as the market matures, subsidies will no longer be needed.

PET

The primary factor influencing the demand for used Ontario PET bottles is that, in the North American context, there is an undersupply of post-consumer PET bottle feedstock.

As of July 1, 1990, PET recycling firms in North America have a combined capacity to recycle 158,000 tonnes of PET annually.[29] It is estimated that current U.S. states with deposits on PET bottles, plus American and Canadian curbside households can generate only about 113,000 tonnes of PET annually.[30] Therefore, at present there is a 45,000 tonne shortfall in the supply of PET bottles. Planned expansion will increase this capacity to 239,000 tonnes by January 1992 which is 126,000 tonnes in excess of 1990 supply.

This strong demand for used PET bottles is good news for collectors and processors as it is driving up the price of the secondary material. Until two years ago recycled PET sold for about $0.28/lb. For the past two years it has been at approximately $0.40/lb. and the price is expected to continue to rise closer to the "ceiling" price of virgin PET (currently at $0.60/lb.) as the market stabilizes.

Another factor influencing the demand for recycled PET is that, from a market perspective, PET recycling is a profitable enterprise. As stated above, PET reprocessors are paying as much as $0.13/lb. for baled PET. The recycled material is sold to end users who are seeking recycled content in the products for about $0.40/lb.

HDPE

The factors influencing demand for post-consumer HDPE are similar to those noted above for PET. There is strong North American demand for the

material and, as is shown above, reprocessing HDPE can be quite profitable. It is also in the industry's interest to recycle HDPE as well as utilize the recycled HDPE in new products to close the recycling loop.

However, there are problems associated with the collection and sorting of HDPE bottles. Unlike PET, where an easily identifiable product line of soft drink bottles exists, there is no single product line in the province that uses only HDPE. This is in contrast to the U.S. where virtually all milk jugs are made from HDPE.

To collect HDPE in Ontario, a program must, collect all plastic bottles and sort for the higher value PET and HDPE. However, since the majority of plastic bottles are HDPE, there is an opportunity to increase HDPE collection through consumer education.

9.2.3 Factors that Influence the Choice between Secondary and Primary Material

Until recently, the price of recycled PET and HDPE was only 1/3 to 1/2 the price of virgin. However, bottle grade recycled resin now sells for about 2/3 the price of virgin resin as end-users have demanded recycled content in their non-food packaging.

This has been a boom for reprocessors, making it attractive for companies to reprocess and sell the recycled material. At the same time, the material is still priced attractively to end users (assuming the material meets the various quality specifications).

The economic assumption behind Superwood type-applications is that even though a minimal price is paid by Superwood for the material, as landfill tipping fees rise the cost of collecting the material and sending it to Superwood will be less than landfilling.

However, the sortation will remain problematic until technology or consumer education can reduce the cost of manual sorting.

9.2.4 Price/Elasticity Analysis

Plastic represents an expanding portion of the solid waste stream. Its share, by weight, of the total has risen from about 3 per cent in the early 1970s to about 7 per cent (almost 400,000 tonnes) at present. Measured on a volume basis, however, the current share of plastic is about 18 per cent.[31] Plastics used in residential and commercial sectors tend to have a much shorter economic life

than industrial plastics. An increase in the consumption of plastic in the former sectors induces an almost immediate effect on the quantity of plastic found in the municipal waste stream. Plastic packaging is increasingly used as a substitute for paper, metal and glass packaging materials, materials that are more readily recovered and recycled.

Prices recently offered for waste plastic are indicative of the lower value of material recovered from municipal wastes due largely to contamination[32] as opposed to that shipped directly from industrial and commercial generators.

- PET baled, minimum load 13.6 tonnes): $385/tonne
- HDPE (baled, clear only): $198/tonne
- Mixed rigid (bottles and containers only): $99/tonne
- Mixed (unsorted): $0 - $110/tonne

No estimates of the price elasticities of demand and supply were found in the literature. The fact that the market for clean, sorted plastic (i.e., from industrial and commercial generators) is supply limited indicates that the price elasticity of demand should be quite high. The responsiveness of supply to changes in price is clearly low, since the market is characterized by chronic excess demand. The same cannot be said for the elasticities related to plastic recovered from municipal recycling programmes, except perhaps for that portion recovered from the commercial sector. Markets for mixed, contaminated plastic have yet to be firmly established. The implication is that the elasticity of demand will be quite low, and the elasticity of supply relatively high.

Elasticity of Demand Issues

Plastic contained in municipal waste streams can be recovered to serve either the market for individual plastic resin types, or the (still nascent) market for mixed plastic, or both. The key policy element is the potential for greater source separation of plastics, particularly at the residential level, given the relatively high value (and value added) of these materials.

Discarded *homogeneous plastic* competes in the packaging materials marketplace with virgin plastic and non-plastic materials like glass, steel and aluminum. Industrial and commercial sources of plastic in Ontario have been supplying secondary plastics markets through private dealers for many years. Markets have always been available for clean, homogeneous plastic waste. At present, some thirty firms compete for secondary plastic in an Ontario marketplace that appears to be supply constrained.[33] This excess demand is due, in part, to a worldwide shortage of ethylene, from which several types of plastic is made. The current market situation may be short lived since new ethylene capacity can be expected.[34]

Clean and sorted (or sortable) household plastics have considerable potential as high value virgin plastic substitutes (it should be noted that, for health reasons, provincial and federal regulations bar the reuse of food and beverage packaging materials in the re-manufacture of food and beverage containers[35]). HDPE plastic cut from the municipal waste stream commands a high price relative to mixed plastic, which is often provided to end users for free. The price differential at present is at least $99/tonne based on a price of $0.075/lb for HDPE at Resource Plastics *versus* $0.03/lb for mixed plastic containing up to 70 per cent HDPE at Superwood.

The market for *mixed plastic* from the municipal waste stream is limited. While sorted, homogeneous plastics can be remanufactured into their constituent resins, and plastic product made from mixed plastic can be made into a more limited number of items (e.g. plastic lumber, pipe, cable spools and planters). These products must compete with those made from non-plastic materials in well-established markets. In North America, these new uses for mixed plastics are in the experimental stages, and no markets for the finished products made with mixed plastics have been firmly established.

Elasticity of Supply Issues

As stated above, about 400,000 tonnes of plastics are consumed and discarded in Ontario annually. Only a small portion of this stream is recovered either voluntarily or through municipal blue box programmes. Wide scale recovery of plastics from the municipal waste stream began in 1989. Prior to that time, only clear plastic soft drink bottles (PET) were collected. Municipalities collecting plastic through blue box programmes include Metropolitan Toronto, the City of Guelph and the City of Mississauga. The main obstacle to additional recovery is that while clean, sorted plastic is in high demand and commands a premium market value (2/3 the price of virgin resin), unsorted, contaminated plastics does not (municipality collected plastic is contaminated with food waste, and labels and caps made from other materials.[36] At present, end users of PET or HDPE plastics are paying recyclers about $880/tonne for ready to use material). Additional supplies should be forthcoming but need to address the difficulty and costs of sorting mixed plastics into different resin groups.

Government policy oriented to reduce the amount of non-reusable types of plastic in the municipal waste stream could significantly affect future supply. Likewise, legislation phasing out plastics that are not re-usable, by reason of their inherent, as opposed to in-use, characteristics could enhance supplies by reducing the level of contamination. The elasticity of supply is strongly influenced by such policy initiatives, particularly for this category of secondary materials.

9.3 *Assessment of Market Ability to Absorb Supply*

PET

RIS projects that in 1992, 1,880 tonnes of PET will be recovered from the residential and ICI waste streams. This is expected to rise to 6,360 tonnes by the year 2000.

Existing annual North American capacity to reprocess PET is at 158,000 tonnes. However, current North American supply is only 113,000 tonnes This difference between supply and demand is expected to widen as 81,000 tonnes of new processing capacity comes on stream in the next year and a half without commensurate increases in recovery rates of used plastics.

There appears to be every indication that the market can absorb all North American recycled PET bottles for at least the next 1-3 years. However, because PET markets draw from U.S. as well as Canadian supply it is difficult to predict whether there will be an oversupply of the material in the middle and later part of the decade without undertaking an analysis of projected demand for and supply of used PET in both countries, which is outside the scope of this study. However, this suggests that PET collection and reprocessing capacity be tracked to monitor the impact on Ontario for markets.

HDPE

Research conducted by RIS in 1989 estimated that 32,000 tonnes of HDPE was recycled in the U.S. in 1987.[37] (There was no curbside collection of HDPE in Canada in that year). Optimistic scenarios project no more than 113,000 tonnes of HDPE will be recovered curbside in North America in 1991.[38]

Surveys of selected HDPE processors conducted by RIS, indicate known processing capacity for post-consumer HDPE at 116,000 tonnes annually in the eastern states and Ontario. However some major processors (e.g. Wellman, Inc.) report unlimited capacity for post-consumer HDPE.

Therefore, over the next 1-3 years, it is expected that demand for used HDPE will exceed supply. Again, monitoring of demand and supply for HDPE across Canada and the U.S. will be important to track development of this market.

Other Resins

According to SPI data, as much as one half of all RPCs generated in Ontario are made from resins other than PET or HDPE. While markets are strong for these two resins, there is virtually no recycling infrastructure in place for other resins such as PS, PP, and PVC. Despite activities taking place within the polystyrene industry (i.e. Canadian Polystyrene Recycling Association) and the polyvinylchloride industry (i.e. PVC reprocessors will pay the going PET price for PVC bottles) it is not anticipated that these ventures will, on their own, divert large quantities of material from landfill.

The relatively small amounts of PP, PVC and PS bottles in the waste stream raise doubts as to whether separate recycling infrastructures in Ontario will be viable for these resins.

Some view mixed plastics processors, such as Superwood as a recycling alternative for PS, PVC and PP containers. However, as stated above, over half of Superwood's feedstock must be polyethylene, which is obtained either through post-consumer recycling programs or through "clean" industry feedstock.

In addition, the limited quantities of material recycled by Superwood coupled with concerns regarding the strength of the market for the plastic lumber product make it doubtful that mixed plastic processing will provide a recycling alternative for a significant amount of non- HDPE/PET resins.

For recycling of non-HDPE/PET bottles to become a reality one or both of the following need to occur:

- mixed plastic sorting (either manual or mechanical) must become a reality in Ontario. Once the materials are sorted into resin groups, they can be marketed to reprocessors working within a specific resin category. At the same time, the advent of mixed resin sorting across North America should provide a stable supply of homogeneous resins that will be necessary to spur investment in non-HDPE/PET recycling operations.

  (It should be noted that SPI through EPIC (Environment & Plastics Institute of Canada), is examining the feasibility of establishing a manual mixed plastic sorting facility for Ontario);

- the costs of collecting, sorting and transporting RPCs made from PS, PVC or PP must be incorporated into the original virgin price. Alternatively resin producers must be prepared to assist financially the recycling of these elastics. There are a number of factors which impact the cost of collecting rigid plastic containers and, therefore,

the costs vary significantly between programs. Some estimates are that collection costs may be a high as $1,000/tonne (45 cents/lb)when plastics collection is added to an existing program. However, the price paid for mixed rigid plastics is only in the 0-5 cents per pound range[39].

Plastic Film

Plastic films can be recycled as long as they are sorted into resin groups that are technically compatible in the recycling process. For example, Resource Plastics in Brampton does much of its business in recycling plastic films.

However, there are no viable options that exist for recycling post-consumer plastic films other than the limited amounts that are used by mixed plastics reprocessors such as Superwood.

The major obstacle to wide scale post-consumer plastics film recycling is the amount of contamination (e.g. food residue) as well as the non-compatibility of film resins. For example, the predominant film that is used to wrap meat, cheese, and poultry is made from PVC which is not only technically incompatible with polyethylene wraps, but also emits hazardous gas when heated and, because it has a different melt point than polyethylene film, can clog recycling equipment being used to process polyethylene.

Although there are no significant post-consumer film recycling markets, there will be increased pressure placed on the industry by governments and and the public to recycle this material. However, proven methods of collecting and sorting plastic film need to be developed before film collection will make significant inroads in Ontario.[40]

Assuming Increased Generation Levels

The preceding analysis assessed the market's capacity to absorb materials based on current supply trends. Even in the year 2000, this study projects only 23% of RPCs and film will be recovered. However, it is possible to analyze what the effect on PET and HDPE reprocessing markets would have been if all used PET and HDPE RPCs in the 1989 Ontario waste stream had been collected.

In 1989 there was a total of 3,935 tonnes of PET bottles and 39,210 tonnes of HDPE RPCs generated in the residential and ICI sectors. As indicated above, there is 45,000 tonnes excess capacity in the PET reprocessing industry and possibly as much as 50,000-75,000 tonnes of excess demand for post-consumer

HDPE. (It is difficult to estimate capacity of HDPE reprocessors as some larger companies like Wellman claim to have "unlimited" capacity.)

Nonetheless, it is clear that in 1989 the reprocessing industry would have been able to reprocess all post-consumer PET and HDPE bottles in Ontario, although the cost/price gap remains a barrier to its inclusion in blue box programs.

The same, obviously, does not hold true for RPCs in PP, PVC, and PS or plastic film as markets do not exist for these products.

9.3.1 Summary

The capacity of industry to reprocess post-consumer PET and HDPE RPCs far exceeds present and anticipated supply of the feedstock. Therefore, availability of the market to absorb these resins is not considered to be a barrier to increased plastics recycling in the foreseeable future.

However, until the costs of collecting and processing post-consumer RPC's and film are at least offset by the price paid for the material (including avoided disposal costs), plastics recycling will continue to play a less than optimal role in diverting plastic waste from disposal.

9.4 References

1. Conversation with Charmian Entine of The Society of Plastic Industries of Canada.
2. Metropolitan Toronto Department of Public Works, Markets for Materials from Solid Waste (SWEAP Document 3.4), 1989, p. 7:1.
3. The Environmental Report Vol 1, Fall, 1990 p. 2.
4. Rigid plastic containers are most commonly made from the following resins: high density polyethylene (HDPE), polyethylene terephthalate (PET), polystyrene (PS), polypropylene (PP), polyvinyl chloride (PVC) as well as various combinations of resins and barrier materials.
5. The Society of Plastics Industries of Canada has introduced a voluntary coding system designed to assist consumers and recycling program operators distinguish between various plastic resins in rigid container applications. The codes are as follows:
   1-PETE (polyethylene terephthalate)
   2-HDPE (high density polyethylene
   3-V (polyvinyl chloride)
   4-LDPE (low density polyethylene)
   5-PP (polypropylene)
   6-PS (polystyrene)
   7-OTHER

6. Source: Society of Plastics Industries of Canada (SPI). SPI data on Canadian plastics generation was multiplied by a factor of .4 to arrive at Ontario figures. (While SPI does not have detailed data on the percent of Canadian plastics packaging consumed in Ontario, SPI staff, in conversation, provided an estimate of 40%). To arrive at the split between RPCs in RSW versus ICI it was assumed that RPCs account for 9% of RSW (confidential report prepared by Proctor and Redfern Limited, July 1990). RPCs in the ICI stream were calculated by subtracting RPCs in RSW from total RPCs.
7. Assumes that PET bottles account for .9% of MSW (based on report prepared by Proctor and Redfern Limited entitled Mixed Rigid Plastic Container Separation and Recycling Facility Feasibility Study (July 1990) and the 90% of PET bottles are consumed in the RSW stream (SPI). Figures for the ICI stream are derived by subtracting PET generation in the residential sector (36,340) from the total RPC tonnage of 81,680 (=45,340 tonnes).
8. Assumes that 48% of RPCs generated in the RSW and ICI sectors are HDPE (based on SPI data of resin consumption by packaging type).
9. Based on SPI data.
10. All figures for plastic generation for the years 1992 and 2000 are based on an annual growth rate of 6.3% (Based on SPI estimates as well as information contained in a confidential report produced by Proctor and Redfern Limited in July 1990).
11. Information provided by Ontario Multi Material Recycling Inc (OMMRI).
12. Recovery data was obtained from OMMRI as well as through conversations with program operators.
13. Information provided by Ontario Multi Material Recycling Inc (OMMRI).
14. Recycling Times (Vol. 2, No. 6) March 13, 1990.
15. There is no means of predicting, with certainty, the percentage of plastic film that will be recycled in the later part of the decade given that film recycling is not yet established. An estimate of 15% recovery rate for plastic film in the year 2000 is based on the assumption that wide scale sorting technologies for films are entering the market in the later part of the decade.
16. There are a number of markets for mixed rigid plastic containers in Ontario and the eastern U.S. including:
- Superwood, Mississauga
- Resource Plastics, Brantford
- Polymerix, Lincoln Park, New Jersey
- Alaric, Inc., Tampa Florida
- Shuman Plastics, Depew, New York.
17. Refer to Figure 9.1
18 Personal communication with Dominique Pottelle, Twinpak, Montreal.

19 Regulations 622/85 and 623/85 of the Ontario Environmental Protection Act requires that a recycling rate of 50% be achieved for the PET soft drink bottle.

20. Personal communication with Ed Carreras, Day and Zimmerman, New Jersey.

21. The PET Recycling Guide (published by Twinpak to provide information to Ontario recycling program operators).

22. Conversation with Jim Horn of Resource Plastics, Brantford, Ontario.

23. Depending on the design of the program, "mixed plastics" can refer to mixed plastic bottles, mixed plastic rigid containers, all rigid plastics, or all plastics (including film).

24. Conversations with Jim Horn and Barry Wood of Resource Plastics, Brantford, Ontario.

25. This analysis is based on information provided by officials of Resource Plastics.

26. Conversation with Jim Horn of Resource Plastics, Brantford, Ontario.

27. Conversation with staff of Superwood, Mississauga.

28. Modern Plastics, January 1990 reports 165,000 tonnes of polystyrene consumed in Canada. At 35% consumption, Ontarians consume 59,000 tonnes per year.

29. Modern Plastics, July 1990.

30. RIS estimate.

31. Metropolitan Toronto Dept. of Works, Markets for Materials from Solid Waste (SWEAP Document 3.4), 1989, p.7:8.

32. 17. Ibid, p.7:13.

33. Ibid, p. 7:1.

34. Ibid, p. 7:15.

35. Ibid, p. 7:14.

36. Ibid, p. 7:1.

37. Final Draft Report on Technical and Strategic Services for the Collection/Recovery of Post Consumer Plastics, Resource Integration Systems for E. I. Dupont De Nemours and Company, Inc., 1989.

38. Assumes that 20,000,000 North American households collect HDPE at curbside and recover 40% of the material.

39. A Report on Collection Method Profiles and Material Recovery Facilities Assessment, Resource Integration Systems for The Council of Solid Waste Solutions, 1990.

40. Although there are early indications that the Peterborough Ontario film collection pilot is showing promising results, it is too early to attempt to draw conclusions from this program.

10.0 CONTAINER GLASS

10.1 Supply

10.1.1 Generation By Sector

Current Generation

Container glass (bottles and jars) in the waste stream consists primarily of food and beverage containers and, to a lesser extent, pharmaceutical and cosmetic containers. Consumers Glass is the only glass container manufacturer in Canada following the purchase of Domglas by Consumers Glass in 1989. It produces approximately 80% of the estimated Ontario generation.[1] It is the only end market in Ontario for post-consumer glass containers.

The amount of container glass in the Ontario waste stream is estimated at 330,000 tonnes in 1989.[2] This estimate includes imports of containers which are estimated to be 20% of Ontario generation.[3] CH_2M Hill estimates that in 1989 the residential sector generated 268,500 tonnes of container glass or about 70 kilograms (kg) per household.

The generation of glass from the ICI sector was therefore estimated to be 61,500 tonnes, the difference between total generated tonnes and CH_2M Hill estimated residential tonnes.

Projected Generation

Growth in total tonnes of container glass is estimated to be approximately 1% annually.[4] This low growth rate is primarily due to loss of market share to plastic containers.[5]

At a 1% annual growth rate, generation of container glass in the residential sector is estimated at 276,600 tonnes and 299,500 tonnes in 1992 and 2000 respectively. Generation of container glass in the ICI sector is estimated at 63,400 tonnes and 68,700 tonnes in 1992 and 2000 respectively.

10.1.2 Current and Projected Diversion Levels

Current Diversion

Consumers Glass purchases post consumer glass containers from municipal recycling programs, private collectors (e.g. Joe's Recycling and AAA Recycling) and from the soft drink bottlers and breweries (refillables recycled after trippage).

Consumers Glass reported purchasing approximately 31,000 tonnes of container glass from municipalities in 1989 (approximately 15 kg per blue box household).[6] Most of this tonnage was mixed colured glass.

From the ICI sector, an additional 5,800 tonnes were purchased by Consumers Glass primarily from two private companies that collect glass containers from restaurants, bars, hotels and airline operations located in Metro, Peel, Durham and the City of Toronto.[7] Most of this tonnage was mixed coloured glass.

Approximately 11,000 tonnes of colour sorted used refillable beer containers were recovered from the ICI sector (refillables recycled after trippage) from the beer industry and sold to Consumers Glass.[8] Some additional tonnage of mixed coloured refillable containers from the soft drink industry was recycled but estimates were unavailable.[9]

Total diversion in 1989 for the residential and ICI sectors is therefore 31,000 and 16,800 tonnes respectively.

Projected Diversion

For the purposes of this analysis it is assumed that the current deposit system will not be expanded.

In September of 1989, Consumers Glass announced to Ontario municipalities a new pricing policy for container glass from municipal recycling programs.[10] (Details of that pricing policy are outlined later in the demand section). As a result of that new pricing policy, municipalities started colour sorting in the later part of 1989.

In 1990, Consumers Glass reported that approximately 45,100 tonnes of colour sorted glass (flint and amber/green mixture) were purchased from municipalities. Consumers Glass reported that another 12,600 tonnes of mixed coloured glass was diverted from landfill and is currently stored in Hamilton. Some of this was purchased by Consumers Glass and some was contaminated containers accepted at no payment (as per an agreement with Metro Toronto) for the purposes of determining the feasibility of grinding contaminated glass to a fine particle size and feeding it in small amounts into the glass manufacturing process.[11] The facility to grind the contaminated glass was to be operational around the first quarter of 1991.[12] Grinding of a test sample is expected to start the end of May 1991.[13]

Therefore, an estimated 57,700 tonnes (approximately 28 kg per blue box household) were diverted from the municipal waste stream in 1990. It should be noted that some of this tonnage includes container glass from ICI locations that are also part of a municipality's blue box program.

Tonnage recovered directly from ICI recyclers (e.g. by Joe's Recycling and AAA Recycling) in 1990 was approximately 2400 tonnes.[14] Tonnage purchased from the breweries was the same as in 1989 or 11,000 tonnes.[15] In total, an estimated 13,400 tonnes was from the ICI sector directly.

In 1992, it is estimated that approximately 87,000 tonnes will be recovered from the residential sector through expanding the blue box collection system to 2.5 million households. This is based on a recovery rate by participating households of 30 kg resulting from increased awareness and promotion as experienced in the City of Barrie after the implementation of a promotion campaign in 1991 to increase recovery rates from blue box households.[16] This projected recovery rate assumes that rejections of glass containers will be minimized due to increased education of suppliers by Consumers Glass about contamination. Overall, rejections of glass container tonnage for 1990 were estimated at approximately 10% of total shipments where rejections for green/amber and mixed were higher than for flint.[17]

Tonnage from the breweries is not expected to change from that reported in 1989 due to anticipated flat sales predicted for these industries in the 1990's.[18] RIS has been unable to predict recovery tonnages from Joe's Recycling and AAA Recycling. Therefore, RIS has assumed a similar recovery as in 1990. Therefore, total ICI recovery in 1992 is estimated at 13,400.

In 2000, it is anticipated that an estimated 140,000 tonnes will be recovered through expanding the blue box collection system to 3.5 million households. This is based on a recovery rate by participating households of 40 kg resulting from increased tonnage from ICI locations serviced by municipal programs as experienced in the City of Barrie after the implementation of a promotion campaign in 1991 to increase recovery from ICI locations.[19] It should be noted that this estimate would likely be a minimum because it is based on recovery increases from the ICI sector after only 3 months of monitoring. As well, this projected recovery rate assumes that rejections of glass containers will be minimized due to increased education of suppliers by Consumers Glass about contamination.

Again, tonnage from the breweries is not expected to change from that reported in 1989 due to anticipated flat sales predicted for these industries in the 1990's. Therefore, total ICI recovery in 2000 is estimated at 13,400.

Therefore, the summary of glass generation and recovery for 1989, 1992 and 2000 is:

Table 10.1
Glass Generation and Diversion Estimates (tonnes/year)

	1989	1992	2000
Residential Generation	268,500	276,600	299,500
Residential Diversion	31,000	87,000	140,000
ICI Generation	61,500	63,400	68,700
ICI Diversion	16,800	13,400	13,400

10.1.3 Potential for Increased 3R's Activity

Reduction

Consumers Glass expects that developments in glass manufacturing will result in a reduction of glass weight by approximately 5-10% over the next 5-10 years.[20] Therefore 1992 and 2000 generation figures have been reduced by 5% in 1992 and 10% in 2000 to account for light-weighting. Recycling is reduced by 5 and 10 percent to reflect the impact of light-weighting and to avoid double counting of diversion estimates (see Table 10.2 below).

Table 10.2

Glass Generation and Diversion Estimates Through Lightweighting (tonnes/year)

	1992	2000
A) Total Glass Generation	340,000	368,200
B) Light-weighting @ 5% and 10%	17,000	36,820
C) Total Recycling (Residential + ICI - 5% and 10%)	95,380	138,060
Total Glass Diversion (B+C)	**112,380**	**174,880**

Reuse

Glass is inert and therefore it is a packaging material that can be reused. Approximately 25% of Consumer Glass production is targetted at reuseable (refillable) containers primarily for the beer industry. As mentioned earlier, industry predicts flat sales in the 1990's for this industry.

Consumers Glass was unable to predict inroads of refillables into other container applications as this is dictated by the customers of Consumer Glass based primarily on the type of product being packaged, their perceived market needs, consumer preference, and, in Ontario, on regulatory requirements under the Environmental Protection Act.[21]

Recycling

There is the potential to increase the recovery rate for glass containers from both the residential and ICI sector. The estimated year 1992 and 2000 recovery figures represent approximately a 26% and 41% recycling rate respectively. This recovery rate could be increased with increased recycling in the ICI sector.

There is also potential for increased glass recovery from the residential sector. Sampling of waste from blue box households indicates that the capture rate for glass containers is approximately 80%.[22] Therefore, a 100% capture rate could increase residential tonnages by 20%.

Summary

In total, diversion through recycling and lightweighting in 1992 is estimated at 100,830 tonnes for the residential sector and 16,570 tonnes for the ICI sector. Total diversion through recycling and lightweighting in the year 2000 is estimated at 169,950 tonnes for the residential sector and 20,270 tonnes for the ICI sector.

10.2 Demand

10.2.1 Market Structure

The market for Ontario glass containers is currently limited to one manufacture i.e. Consumers Glass, the only manufacturer of new glass containers in Ontario.

In May 1989, Consumers Glass purchased the assests of Domglas Inc. making Consumers Glass the only Canadian manufacturer of glass containers. Consumers currently operates 4 glass plants in Ontario located in Hamilton, Bramalea, Milton and Toronto.

Prior to 1980, the use of glass containers to manufacture new containers was primarily limited to in-factory broken or discarded glass containers (e.g. glass discarded as a result of colour changes) resulting during the manufacturing process. During the past decade, Consumers Glass has substantially increased the use of post consumer glass to the extent that in 1989 and 1990 Consumers Glass diverted 47,800 and 71,100 tonnes respectively (refer to earlier section for details). Consumers Glass has targetted a 50% recycling rate by the year 2000.[23]

Before glass containers can be used to make new containers, they must be processed to remove attachments to the bottle e.g. caps, neck rings, labels, and crushed to a certain size specification before the cullet is combined with virgin materials to make new glass containers. This process is commonly called glass beneficiation. There are two processors of glass containers currently in Ontario. Firstly, there is Consumers Glass itself which operates its own beneficiation plant located at its Toronto manufacturing facility.

Secondly, Rosen Industries operates a beneficiation facility in Kitchener. (There was in 1989 a joint venture operation between Consumers Glass and a U.S. processor. This facility was called Multi Container Recycling Inc. and it was located in Mississauga. It was subsequently closed in 1990.)

As of the beginning of 1991, Rosen is processing on behalf of Consumers Glass all of the green/amber glass collected from Ontario municipal curbside collection programs. Consumers Glass is processing all of the flint from municipal programs at its Toronto plant. Those municipal programs that still collect some mixed coloured glass (for instance from apartments) are shipping to the storage site in Hamilton (mentioned earlier) operated by Rosen.

With the increased recovery of post consumer glass containers over the past decade, Consumers Glass has now reported that there is a long term surplus of coloured cullet which Consumers will not be able to absorb.[24] Consumers Glass has identified other markets for glass containers as potential end uses primarily for contaminated glass and coloured cullet. These include using cullet as a partial replacement for aggregate in asphalt production, commonly called glasphalt; using container cullet in the production of fibreglass insulation; domestically bottling foreign wines and spirits; and, manufacturing new products made of glass.[25] All of these identified markets have to be developed if they are to play a major role in the recycling of glass.

In the earlier 1970's, two glasphalt demonstration road projects were developed and carried out by a joint industry and government task force lead and sponsored jointly by Domglas and Consumers Glass (under the auspices of the Glass Container Council of Canada). Though unsubstantiated, concern has been raised by some government officials that these test roads experienced accelerated stripping/polishing thereby affecting the surface condition of the roads.[26] As a result, municipal officials have been hesitant to use glasphalt since then. Consumers Glass has reported that the problems that may have occurred with these earlier demonstration projects may have been due to using cullet in too high a percentage of the total glasphalt mixture and in too large pieces.[27]

New York City and Long Island are primarily the main users of glasphalt with New York City being the leader.[28] In 1989, New York City Department of Transport used 27,300 tonnes of cullet in glasphalt.[29] New York City's experience in using glasphalt indicates that cullet can be used up to 20% of the glasphalt mixture by weight for low speed roads without any impact on pavement performance.[30] This evaluation is based on test strips being down for just over 3 years and as a result the State Department of Highways is hesitant to endorse glasphalt as an aggregate substitute until it has monitored performance over a longer period.[31]

In Ontario, Consumers Glass has found that municipal and provincial road officials continue to be reluctant to use glasphalt, even on an experimental

basis, due to the short term experience with its usage in other jurisdictions and because aggregate is relatively inexpensive (in the order of $10/tonne.)[32]

The fiberglass industry has historically used plate and container cullet in the production of fiberglass. RIS knows of one insulation supplier that purchases post consumer colour sorted container glass from a firm located in Alberta called Cannasphere.[33] However, preference is typically for plate glass scrap as compared to container glass because of increased consistency of supply. As well, if container glass is purchased, preference is primarily for flint in order to easily maintain colour consistency of the insulation product.[34]

Consumers Glass has suggested that domestic bottling of imported spirits and wines will assist in handling the surplus of coloured cullet in Ontario. RIS estimates that based on an average container size of 750ml approximately 33,000 tonnes of imported liquor and wine glass containers were sold by the Liquor Control Board during the 1989 fiscal year.[35] Of that amount about 80% is estimated to be coloured glass[36]. Some of this tonnage was directly to licensed establishments estimated at approximately 11,000 tonnes.[37] The reduction impact of domestic bottling may reduce projected surplus of coloured glass containers. This is contingent on many factors such as who supplies the glass containers, what is the actual colour of containers required for bottling and what would be the percentage of cullet used in the production of those new containers.

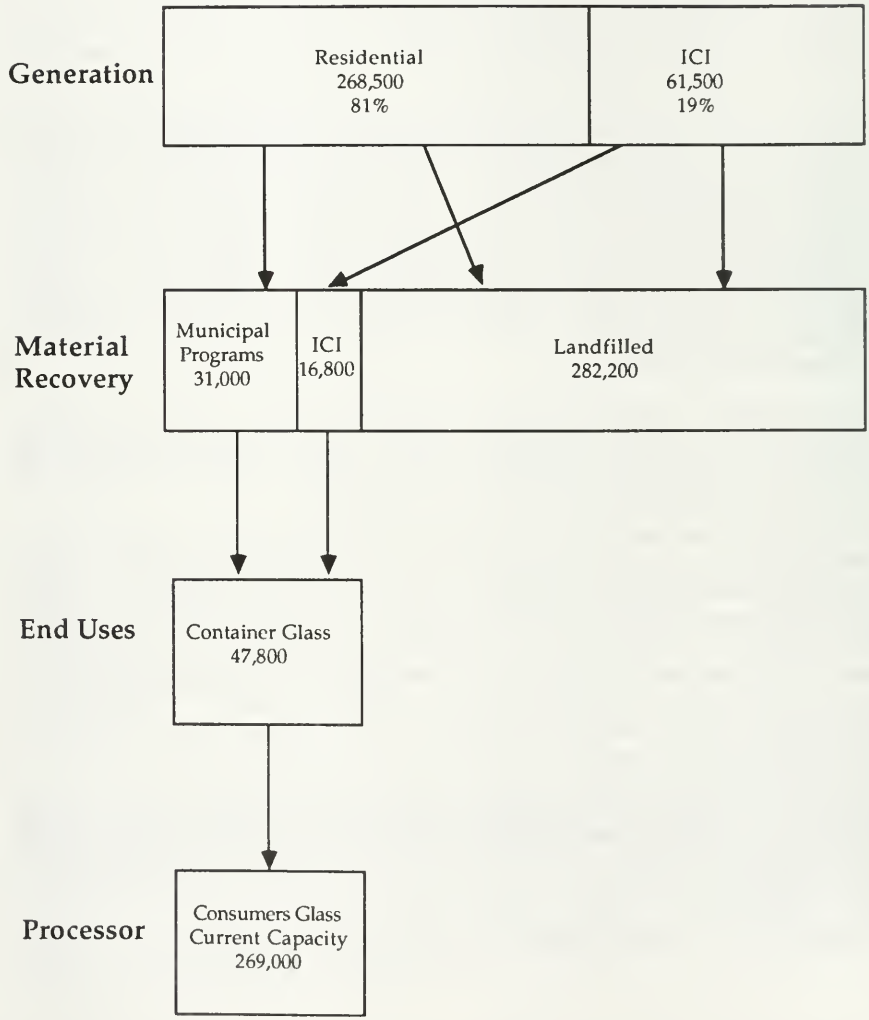
New products is another end market that needs research such as geotextiles which are filled with crushed glass designed to replace conventional drainage pipe and erosion control matting.[38] Product tests indicate that geotextiles perform about equivalent to conventional products.[39]

As mentioned earlier, Consumer Glass announced the development of a system of grinding contaminated glass for use in the production of new glass containers. The grinding enables contaminates, such as ceramics, to melt in the glass furnace. A test sample is expected to be run the end of May, 1991.[40] This system has a capacity to handle 16,500 tonnes of contaminated glass annually. The cost to transport and beneficiate the contaminated glass is estimated at $66-77/tonne which will be borne by Consumers.[41] The need for the grinding process will likely diminish as the stockpiled loads are used and contamination decreases.

It should be pointed that the largest glass container manufacturer in North America, Owens-Brockway, is exploring optical colour sorting and alternative ceramic removal systems, however, there is no commercial technology is not yet available.[42]

Figure 10.1 provides a summary for Ontario markets for Glass.

Figure 10.1
Glass Containers (tonnes per year)
Ontario 1989



10.2.2 Factors Affecting Demand

The prime factor that influences the demand for cullet is the demand for new glass containers. The other factor affecting the demand for cullet is the colour of glass containers required to be supplied to Consumers Glass customers.

Glass containers can be recycled again and again without loss of quality to make new glass containers. The major use for recovered glass containers is in the manufacture of new glass containers.

Consumers Glass is the only glass container manufacturing firm in Ontario, and hence the prime source of potential demand for used glass containers. The combined output capacity of their manufacturing plants in Ontario in 1989 was approximately 400,000 to 450,000 tonnes per year. Some of that tonnage is shipped out of province. As indicated in the supply section for glass, glass sales are expected to be flat over the next decade due primarily to increased market share of plastic containers. Overall, the company could consume 280,000 to 337,500 tonnes of used glass per annum at the above noted rate of output.[43] Generally, this useage of old glass containers would be sufficient to handle the tonnage of glass projected to be suppplied in 2000 or 150,000 tonnes (does not allow for lightweighting) if the glass containers were all one colour.

In reality, glass containers are produced in three different colours, flint or colourless glass, amber or brown and a range of green shades. Since mixed coloured glass can only be used in the production of dark green glass or emerald green glass, Consumers Glass requires colour sorted glass to maximize potential useage of cullet and to ensure a long term market for glass. About 60% of Consumers Glass production is flint glass while amber and green is around 20% each.[44] Clear glass production is capable of utilizing up to 50 per cent cullet; amber about 65% and green glass about 85%.[45] Therefore, Consumers Glass could technically use 135,000 tonnes of flint, 58,000 tonnes of amber and 76,000 tonnes of green for a total of 269,000 tonnes.

As indicated above, the demand for flint is much higher, representing approximately 60% of glass production. In view of this, consumers changed their pricing policy in 1989 to encourage municipalities to colour-sort flint (clear) and coloured (green and brown) glass. As well, they offered a 6-month bonus ending March 31, 1990 to those municipalities that had to change their collection and processing systems to accommodate this requirement. This change requires colour sorting of glass at either the truck or at the processing facility.

Statistics from Consumers Glass indicate that around 50% of glass container tonnage recovered during 1990 from municipal curbside programs was coloured glass.[46] Assuming maximum cullet useage based on 1989

production levels and coloured glass remains at 50% of the total tonnage, Consumers Glass would be able to consume the coloured tonnage projected to be supplied in 2000 provided that there is no further growth in ICI recycling. However, Consumers Glass has indicated that post consumer cullet, in particular green/amber cullet, is of a lower quality than industrial cullet (which has normally been used by Consumers Glass to achieve maximum cullet useage in green production).[47] As a result, Consumers Glass is unable to use green/amber cullet to its technical maximum. Therefore there is a long term surplus of coloured cullet.

10.2.3 Factors That Influence the Choice Between Secondary and Primary Material

The factors that influence the choice between secondary and primary materials for Consumer Glass are primarily quality considerations, primary material supply assurance and the cost of primary materials.

Consumers Glass saves energy when using post-consumer glass because the cullet melts at lower temperatures than the virgin material. The Glass Packaging Institute claims that for every 10% of cullet used, 2.5% of the energy needed to produce glass from virgin materials is saved.[48] Therefore, if Consumers Glass is using 25% secondary cullet in the production of new glass, energy savings of approximately 6 - 7% should be realized. Cullet also facilitates the mixing and melting of the raw materials, shortens the melting cycle time and reduces the wear on the furnace's refractories.

The price paid by Consumers Glass in Ontario for colour-separated glass is currently $66/tonne. Mixed glass that is not colour-sorted is worth $11/tonne.[49] In 1989, Consumers Glass handling and beneficiation cost was $13.20/tonne for flint and $16.50/tonne for coloured glass.[50]

The total batch cost for producing glass from primary materials is between $68.20-$71.50/tonne. This batch cost will vary depending on the production facility and the type of product being made. The batch costs of using secondary materials is approximately $79.20/tonne to produce flint and $82.50/tonne to produce green glass. Including transportation, it is estimated that the grinding facility process mentioned earlier will cost between $66 and $77 per tonne. Therefore, Consumers Glass is currently subsidizing the cost of using secondary materials.[51]

Quality of cullet will continue to remain a major factor in the use of post-consumer cullet. Beneficiation equipment is unable to remove contaminants that are not inherent to the glass container e.g. ceramics, non-container glass and aggregates. Ceramics in particular can survive the melting process intact and cannot be totally handpicked because of being broken from collection, storage and transport. As a result, they become embedded in newly formed

containers. Ceramics weaken the strength of containers causing them to break resulting in a possible serious injury. As well, ceramic contamination can cause serious production problems. As a result, it is essential for cullet suppliers to control quality of cullet. If not, shipments of contaminated cullet will be rejected.

In mid-1989, Consumers reached an unacceptable level of contamination in shipments of cullet. The contamination of container cullet by ceramics continues with amber/green glass and mixed cullet. In 1990, rejection rates were about 2 to 3% for flint while green/amber and mixed cullet were at around 15% and 30% respectively.[52] The higher rejection rate for coloured glass is primarily due to not hand sorting the coloured cullet.[53] Hand sorting all container glass is likely to reduce contamination.

Some measure of primary material (sand, limestone, etc.) must be used on an ongoing basis in order to ensure long term supplies. Feedstocks were 100 per cent secondary material, primary material producers would close.[54] Glass manufacturers would not, thereafter, have an alternative source of supply as secondary material supplies diminish and demand increases or stays constant.

10.2.4 Price/Elasticity Analysis

Including cost savings due to energy saved by using cullet instead of primary materials, used glass is purchased and processed for at least 10 per cent more than the unit cost of primary materials. Savings accruing through longer refractory life associated with proportionally higher use of cullet (lower furnace temperatures) are not included in this price differential, and may, if taken into consideration, very nearly equate the two prices.[55]

No elasticities of demand were found in the literature.

Elasticity of Supply Issues

Cullet useage by the glass container industry has occurred in Ontario for many years. Until recently, commercial and industrial container glass was the primary source of secondary material. The used glass produced from these sources is of the highest quality.

From the perspective of the demand side of the market, used glass from these sources is a commodity quite distinct from used glass produced by municipal recycling programs, even where curbside recycling is practised. It is not surprising then, that prices paid for used glass in North America from these sources has been historically higher, on average, than prices paid to municipalities (excluding Ontario). Estimates of the price elasticities of supply for used glass recovered from "voluntary" sources of this type range from 0.1 to 0.71.[56]

Glass recovered from municipal blue box programs in Ontario is generally of lower quality (primarily due to contamination) than glass recovered voluntarily.[57] Accordingly, municipality recovered glass is associated with a relatively low price elasticity of supply, perhaps due to the generally low demand for this type of secondary material. Like mixed waste paper, municipal supplies of used glass may only be tapped when demand for containers is particularly high. Otherwise, demand is slack. Supply is expected to respond only to wide swings in price.

Prices for mixed glass have fallen dramatically, partly as a result of an increase in supply and partly due to a decrease in demand. In 1987, for example, Metro Toronto received $30 to $35 per tonne for mixed coloured glass. The current price is between $0 and $10/tonne. Colour separated glass commands a much higher price (i.e., $66/tonne at present).

10.3 Assessment of Market Ability to Absorb Post-Consumer Secondary Materials

As noted before, Consumers Glass has a maximum capacity of around 269,000 tonnes for post-consumer, colour-sorted and contaminent free cullet in the production of new glass.

In 1992, 75,000 tonnes of glass are expected to be recovered through municipal curbside programs. Another 13,400 tonnes are expected to be recovered through industrial accounts and ICI recycling programs.

By 2000, it is anticipated that the amount of glass recovered through municipal curbside recycling programs will be approximately 140,000 tonnes. Collection from ICI recycling programs is estimated at 13,400 tonnes.

Consumers Glass has technically the capacity to absorb supply provided that quality is assured. Otherwise, Consumers Glass will not be able to use cullet to its maximum and there will be a surplus of coloured cullet that cannot be used in the manufacture of new containers.

In addition, if glass recycling increases in the ICI sector particularly, or demand for green glass decreases this will only exacerbate the problems associated with a surplus of coloured cullet. It is essential that other end markets be investigated, particularly for coloured glass.

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11.0 TINPLATE STEEL CANS

11.1 Supply

11.1.1 Generation By Sector

Tinplate steel cans are steel cans with a thin tinplate coating used for packaging foods, beverages, aerosols, and paint. Bimetal soft drink and juice cans (tinplate body with aluminum top) are also included in this category.

Only non-aerosol food and beverage cans have been targeted for waste diversion because they are 100% recyclable, have established markets, are already being collected by blue box programs across the province, and exist in large quantities in the residential waste stream.

Aerosol cans are not considered recyclable at this time because they create an explosion hazard in steel mill furnaces. Paint cans are theoretically recyclable but require careful preparation to remove paint residues. For this reason they have been excluded as a target material.

Current Generation

The amount of steel food and beverage containers in the Ontario waste stream is estimated at 99,700 tonnes.[1] This estimate includes imports of filled containers at 2% of Ontario generation.[2]

CH_2M Hill estimates that 75,100 tonnes of the residential waste stream consisted of tinplate steel food and beverage containers. The generation of steel containers is therefore estimated to be 24,600 tonnes from the ICI sector , the difference between total generated and the CH2M Hill estimate for residential generation.

Projected Generation

Tinplate food container waste generation is expected to increase only modestly at 0.5% annually.[3] However, the recent switch to steel soft drink cans with the introduction of 355 ml containers which began in 1990, will produce, when fully implemented, a one-time increase in steel can generation of about 40,000 tonnes. This figure is based on soft drink container sales statistics from the Canadian Soft Drink Association Annual Report 1989-1990. It also assumes no growth in the total number of soft drink cans from 1989 based on industry projections of a flat market in the 1990's and the possibility of a decline in sales with the switch to the 355 ml container.[4] It is assumed that steel will continue to be used for soft drink containers since Coca-Cola has indicated that this change was predicated on the basis of cost.[5]

In estimating generation of steel containers in 1992 and 2000, RIS has apportioned 60% of the 40,000 tonnes resulting from the switch to steel soft drink cans to the residential sector and 40% to the ICI sector. The proportional split is based on estimates provided by an industry representative.[6] Therefore, based on a flat growth projected by industry, generation of steel food and beverage containers in the residential sector is estimated at 99,100 tonnes in 1992 and 2000. Generation of steel cans in the ICI sector is estimated at 40,600 tonnes in 1992 and 2000.

11.1.2 Current and Projected Diversion

Current Diversion

Virtually all current steel can recycling is occurring through blue box programs. The Canadian Tinplate Recycling Council (CTRC) reported that 16,200 tonnes of cans were purchased from recycling operators in 1989 and 25,900 tonnes in 1990.[7]

Recovery from the commercial waste stream is very limited. Steel food cans are collected from selected food service establishments by some municipal blue box programs (e.g. Guelph), although separate recovery data are not kept. In addition, soft drink cans are collected through the OMMRI Recycle It bins of which 8,800 bins have been distributed to ICI locations. The majority of municipal programs do not maintain separate recovery data for the ICI sector. Therefore, it is difficult to estimate diversion and as such, RIS has assumed that 60 tonnes of bimetal cans were recovered in 1989.

Projected Diversion

There is potential for increased waste diversion of steel cans through expansion of blue box programs and increased recovery rates within existing blue box programs.

Modest but stable prices for steel cans in Ontario, coupled with ample market capacity provided by steel mills seems to ensure the long term viability of this material in blue box programs (see Section 11.2.1). Therefore it is projected that all new programs will include steel cans.

In 1992, it is estimated that approximately 58,000 tonnes of steel cans will be recovered from the residential sector through expanding the blue box collection system to 2.9 million households by a recovery rate of 20 kg/household based on recovery levels experienced in Barrie during 1991 and adjusted to take into consideration the switch from aluminum to steel soft drink containers.[8] For 2000, it is estimated that approximately 70,000 tonnes

of steel cans will be recovered from the residential sector through expanding the blue box collection system to 3.5 million households.

In 1992 and 2000, it is estimated that approximately 9,512 and 11,480 tonnes of steel cans respectively will be recovered from the ICI sector. This is a recovery rate of 3.28 kg/household/year based on ICI tonnage recovered in the Barrie More Program and adjusted on a per household basis. This assumes that all communities in Ontario will expand ICI collection in other communities to a similar level as Barrie achieved after three months of implementation.

In making future projections RIS has made the following assumptions:

- 1991 recovery levels from Barrie sampling
- current per household recovery levels of aluminum and steel food and beverage cans will remain constant.
- sales of aluminum versus steel cans will be 25% aluminum cans of the total soft drink cans and 75% steel cans of the total soft drink cans.

A summary of current and projected generation and diversion is provided below in Table 11.1:

Table 11.1

Tinplate Steel Generation and Diversion Estimates (tonnes/year)

	1989	1992	2000
Residential Generation	75,100	99,100	99,100
Residential Diversion	16,140	58,000	70,000
ICI Generation	24,600	40,600	40,600
ICI Diversion	60	9,512	11,480

11.1.3 Potential for Increased 3R's Activity

Reduction

Since 1970, steel containers have been lightweighted by about 30%. The industry does not expect further technological advances in lightweighting.[9]

Reuse

Steel food and beverage containers cannot be reused because of contamination problems.[10]

Recycling

Capture rates determined in the City of Barrie show that soft drink cans and steel food cans both have approximately a 70% capture rate. Based on this figure, there remains an additional 8.6 kg/hhld/year of steel which is not presently recovered from the residential sector.

11.2 Demand

11.2.1 Market Structure

The potential markets for tinplate steel cans consist of steel mills and de-tinning operations. Steel mills combine small amounts of tinplate scrap with other types of scrap to form a scrap charge. Scrap charges are mixed with virgin iron ore in blast furnaces to make new steel products.

De-tinning operations extract the tinplate coating from the steel through an electrochemical process and sell the tin ingots to the tin industry and the de-tinned steel to the steel industry.

The market for post-consumer steel cans in Ontario consists of the major steel companies -- Stelco and Dofasco. These two companies, through their joint venture, the Canadian Tinplate Recycling Council (CTRC), purchase almost all the post-consumer cans generated by municipal recycling programs. (Refer to Figure 11.1 for a summary of the tinplate steel can market in Ontario).

Although the tinplate coating is a contaminant in the steel making process, the steel mills have managed to successfully mix small amounts of tinplate scrap with other forms of scrap in the steel furnaces. The CTRC purchases cans flattened, baled and densified from recycling operations. Flattened and baled cans must be further baled before being utilized in a scrap charge. Steel mills require bales with a density of 100 - 150 lbs. per cubic foot, whereas paper

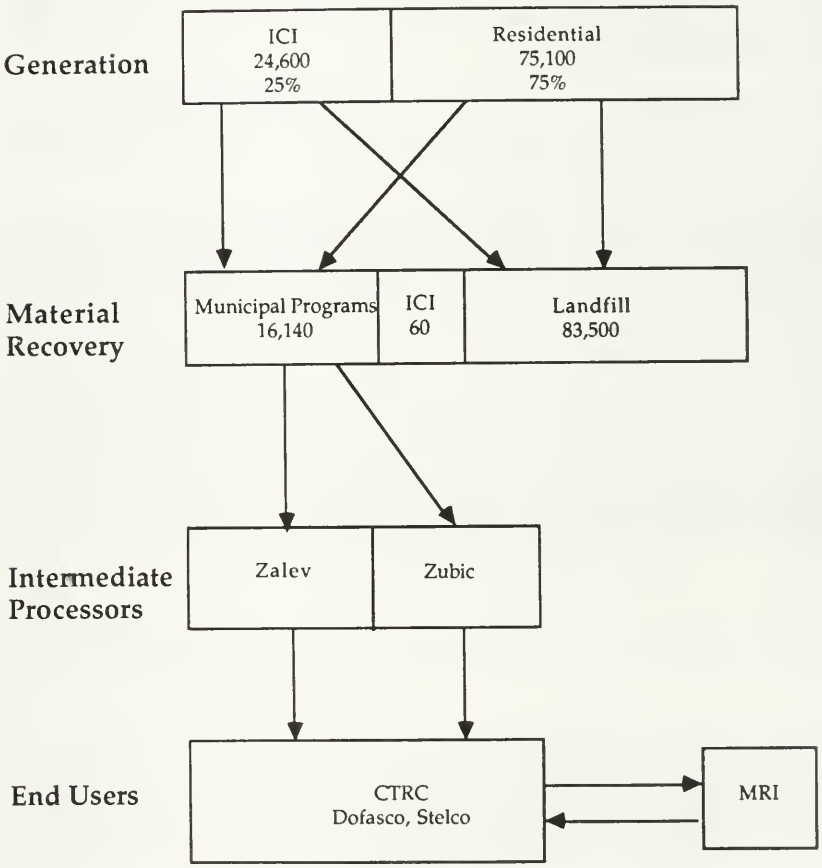
balers used in municipal recycling operations produce bales of 50 -75 lbs. per cubic foot. Cans processed through a densifier instead of a baler can be used directly by the steel mills.

All baled and flattened cans purchased directly from municipal program operators are sent by the CTRC to Metal Recovery Industries (MRI) in Hamilton to be properly baled. MRI charges a processing fee for this service. Two recycling programs, in London and Windsor, sell their cans to local scrap dealers (Zalev Metals and Zubric Metals) who bale the cans to steel mill specifications and ship to CTRC.

In 1989, CTRC paid $77/tonne for baled or flattened cans, and $99/tonne for densified cans. The $22 per tonne premium is to encourage operators to densify cans, so CTRC can avoid the MRI baling cost.

An alternative market for post-consumer tinplate cans not utilized in Ontario is the de-tinning industry. De-tinners electrochemically extract the tin from the steel and sell the de-tinned steel to the steel mills. MRI has a de-tinning operation that processes industrial tinplate scrap but is unable to process post-consumer cans because of contamination problems. Two major U.S. de-tinners -- Proler and AMG -- have developed processing systems that overcome the contamination problems and allow them to use post-consumer tinplate. MRI estimates that a $2 million capital investment would be required to install such a system in their Hamilton plant. However, MRI claims that they could only pay $22 to $44 per tonne for post-consumer tinplate to make the investment viable.[11] Therefore, as long as the CTRC is willing to pay $77 per tonne, de-tinning will not occur.

Figure 11.1
Tinplate Steel (tonnes per year)
Ontario 1989



11.2.2 Factors That Influence Demand

The basic oxygen furnaces used by the steel mills require 30% scrap input. Demand for scrap steel is based on the demand for steel products and scrap steel prices fluctuate based on market conditions. The CTRC has pegged the post-consumer tinplate price at $77 per tonne to support municipal recycling and ensure that tinplate steel cans are included in blue boxes. There is reason to believe this is an artificially high price since MRI claims the true market value of the material is only $22 - $44 per tonne.[12]

By way of comparison, the current price for prime #1 bundle de-tinned steel scrap is $115.50 per tonne. CTRC's cost for tinplate after baling by MRI is also approximately $115.50 per tonne, even though tinplate is lower quality scrap with a high yield loss.[13]

11.2.3 Factors that Influence the Choice Between Secondary and Primary Material

The usage of food and beverage containers scrap is minimal compared to the total steel scrap mix used in Ontario.[14] Factors affecting the choice between primary and secondary material is not an issue for tinplate steel because it is only a small percentage of total scrap usage.

11.2.4 Price/Elasticity Analysis

Ferrous scrap enjoys a large market in Ontario, with some 1.8 million tonnes used annually. The degree to which scrap steel is contaminated with other metals affects the value of the scrap. Scrap low in tin content can be reused in the manufacture of high grade steels. For other end uses however, the removal of tin is not required, since the tin content of any furnace ferrous scrap input mix is relatively low.

Elasticity of Demand Issues

The market for scrap steel in Ontario, including steel cans, is dominated by a single buyer. Prices for cans recovered via municipal blue box programs track those offered for No.2 bundle scrap. The real price of this grade of scrap has fallen over time, from $92.12/tonne in 1983 to $82.50/tonne in 1989.[15]

The elasticity of demand for scrap steel (collected privately from industrial sources) has been estimated to be negative and fairly large: -0.64.[16] This indicates that, for example, for every one per cent increase in the price of steel scrap, the quantity demanded falls by over half of one per cent.

Elasticity of Supply Issues

While the share of steel in the soft drink container market is expected to rise in the short term, it is not likely that the increase in available supplies will affect prices. The price of steel scrap is determined primarily by the market for finished steel products.

The elasticity of scrap ferrous metal supply from private voluntary recyclers has been estimated to be high: up to 3.917 This indicates that as the price of scrap rises with increases in demand for finished steel products, supplies of scrap metal expand significantly.

The elasticity of *steel scrap* supply from municipal recycling programmes is much lower (0.372) indicating that municipal sources of scrap are less responsive than volunteer sources to changes in scrap price.[18] It is not clear, however, that this elasticity would apply specifically to *used beverage cans* collected through municipal blue box programmes. Nonetheless, in consideration of the avoided costs of disposal, the elasticity of municipal supplies is likely to be relatively low.

11.3 Assessment of Market Ability to Absorb Supply

CTRC claims it could utilize up to 100,000 tonnes of post consumer tinplate steel cans from Ontario recycling programs.[19] The market is considered to have adequate capacity to absorb the supply created from any recycling activity between now and the year 2000.

As long as the steel industry continues to subsidize the price of post-consumer tinplate steel, it is not anticipated that the de-tinning option will be pursued in Ontario. It is possible, however, that the steel companies might enter into a processing agreement with MRI to have them de-tin the cans to upgrade the scrap quality.

11.4 References

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12.0 ALUMINUM

12.1 Supply

12.1.1 Generation by Sector

Aluminum in the waste stream consists primarily of single service beverage cans (soft drink, beer and juice). Some food and aerosol cans are also made of aluminum, but from a different alloy than beverage cans. Various rigid and flexible foil products (eg. foil wrap, pie plates, etc.) are also present in the waste stream in minimal quantities.

For the purposes of this study, aluminum beverage cans are targeted for waste diversion because they are made from a uniform alloy with a high scrap value, and exist in sufficient quantities in the waste stream to warrant recycling collection. Foil products are also included because, although they represent a minor portion of the waste stream, they are potentially recyclable.

Current Generation - Beverage Cans

Approximately 28,900 tonnes of aluminum beverage cans were consumed in Ontario in 1989.[1] CH_2M Hill estimates that in 1989 there were 13,500 tonnes of aluminum beverage cans in the residential waste stream in 1989. The remaining 15,400 tonnes is assumed to be in the ICI waste stream.

Projected Generation - Beverage Cans

It is important to note that aluminum soft drink cans were not permitted in Ontario until September 1987, so waste generation in 1987 was insignificant. Since that time aluminum cans have gained about a 60% share of the Ontario soft drink can market.

The levels of aluminum cans in the waste stream will decline substantially in 1991 and beyond due to Coca Cola's decision to shift from aluminum to steel cans in order to lower can costs. Coke originally switched to aluminum cans in Ontario when they were legalized 1987, while Pepsi elected to stay predominantly in steel cans.

It is projected that aluminum soft drink beverage cans in the waste stream will decline by approximately 7,700 tonnes tonnes in 1992 to a total of 8,300 tonnes. Beer can sales, a major component of total aluminum sales, are not expected to change from that reported in 1989 due to anticipated flat sales predicted for the beer industry in the 1990's.[2] Information on juice can sales was not available. The decrease in soft drink container sales is based on statistics from the Canadian Soft Drink Association Annual Report 1989-1990.

It is also assumes no growth in total number of soft drink cans from 1989 based on industry projections of a flat market in the 1990's and due to the possibility of a decrease in sales with the switch to the 355ml container.[3]

In estimating generation of aluminum containers in 1992 and 2000, RIS has apportioned 60% of the 7,700 tonnes in lost sales to steel soft drink containers to the residential sector and 40% to the ICI sector. This proportional split is based on estimations provided by an industry.[4] Based on flat growth projected by the industry for aluminum beverage containers, it is estimated that 8,900 tonnes will be generated in the residential sector in 1992 and 2000. Generation of aluminum cans in the ICI sector is estimated at 12,300 in 1992 and 2000.

Current and Projected Generation - Foil Products

According to Alcan, 4,200 tonnes of foil products were sold into the Ontario market place in 1989.[5] CH_2M Hill estimates that 2,900 tonnes were generated as waste in the residential sector, with the remaining 1,300 tonnes assumed to be in the ICI sector. Alcan projects an annual growth rate of 1.5% for foil.[6] Therefore, in 1992 and 2000 foil generation in the residential sector would be 3,035 tonnes and 3,385 tonnes respectively. Generation in the ICI sector would be 1,360 tonnes and 1,520 tonnes in 1992 and 2000 respectively.

12.1.2 Current and Projected Diversion

Current Diversion - Beverage Cans

Total purchases of used beverage containers from municipal recycling programs reported by Alcan Rolled Products in 1989 was 3,250 tonnes. Cans were recovered through residential blue box programs and through primarily OMMRI recycle-it collection containers in the ICI sector. No data are kept on recovery levels separately for recycle-it bins. It is estimated that the recycle-it bins in the ICI locations recovered about 120 tonnes in 1989. In addition, 5,314 tonnes were recovered through the beer deposit system from the ICI sector.[7] Therefore, 3,130 tonnes were recovered from the residential sector.

Projected Diversion - Beverage Cans

In 1992, it is estimated that approximately 4,060 tonnes of aluminum cans will be recovered from the residential sector through expanding the blue box collection system to 2.9 million households using a recovery rate of 1.4kg/household/year.[8] This rate is based on recovery levels experienced in Barrie during 1991 and adjusted to take into consideration the switch from aluminum to steel soft drink containers. In 2000, it is estimated that approximately 4,900 tonnes of aluminum cans will be recovered from the

residential sector through expanding the blue box collection system to 3.5 million households.

In 1992 and 2000 it is estimated that approximately 1131 tonnes and 1365 tonnes respectively will be recovered from the ICI sector from municipal recycling programs using a recovery rate of .39kg/household/year. This rate is based on recovery levels experienced in Barrie during 1991 and adjusted to take into consideration the switch from aluminum to steel soft drink containers. It also assumes that all communities in Ontario will expand ICI collection in their communities to a similar level as in Barrie (after only operating for 3 months). In addition, at least 5,314 tonnes will continue to be recovered through the beer deposit system. This figure may be higher due to recent changes in the deposit system to increase the deposit on cans in Ontario.

Table 12.1

Aluminum Generation and Diversion Estimates for Ontario (tonnes/year)

	1989	1992	2000
Residential Generation	13,500	8,900	8,900
Residential Diversion	3,130	4,060	4,900
ICI Generation	15,400	12,300	12,300
ICI Diversion	5,434	6,445	6,679

Current and Projected Diversion - Foil

Foil recovery in Ontario was minimal in 1989. Several communities are considering adding foil, however, and Alcan has announced its intention to start taking foil at its Guelph secondary smelter in 1991. Based on Alcan's intention to aggressively seek out foil, RIS has estimated residential diversion at 25% (760 tonnes) by 1992, and 50% (1,700 tonnes) by 2000. No significant ICI recovery is anticipated.

12.1.3 Potential for Increased 3 R's

Reduction

Aluminum cans have been lightweighted to the extent possible. Therefore no further technological advances are likely in this area.

Reuse

Reuse is not feasible for aluminum cans.

Recycling

Capture rates determined in the City of Barrie show that soft drink cans and food cans both have approximately a 70% capture rate. Based on this figure, there remains an additional .6kg/household/year of aluminum cans which is not presently recovered from the residential sector.

12.2 Demand

12.2.1 Market Structure

Beverage Cans

The market for used aluminum cans in North America is composed of buy back centres, consolidators, recycling plants and rolling mills. Cans are purchased by buy back centres and shipped to consolidators where they are baled or shredded and shipped to recycling plants. At the recycling plants cans are melted into can sheet ingot and shipped to rolling mills. Rolling mills convert the ingot into can sheet for sale to can manufacturers.

There are three major aluminum companies in North America -- Alcoa, Reynolds, and Alcan. Both Reynolds and Alcoa are fully integrated, operating buy back centers, consolidation facilities, recycling plants and rolling mills. In the U.S. Alcan only operates recycling plants and rolling mills, and relies on independent consolidators to provide Used Beverage Cans (UBC). There are no can remanufacturer plants in Ontario. The nearest one is in Oswego, New York.

U.S. can manufacturers also operate buy back/consolidation networks and sell UBC back to the aluminum companies. In fact, commitments for future can sheet sales in the U.S. are tied to levels of UBC recovery by the can manufacturers. This is referred to as the toll system, wherein can sheet is effectively rented to can manufacturers and they receive credits for UBC returned.

With the increase in curbside recycling in the U.S., Reynolds and Alcoa have also contracted with material recovery facilities (MRF's) to buy UBC. Alcoa recently signed a long term deal with BFI to take all the UBC from their recycling programs.

The market situation is somewhat different in Ontario. There is no significant buy back activity because beer cans are under deposit and soft drink cans are supposed to be captured by the blue box curbside system. Alcan, which sells 90% of the can sheet sold in Ontario, has agreed not to set up a buy back network that would compete with blue box programs.

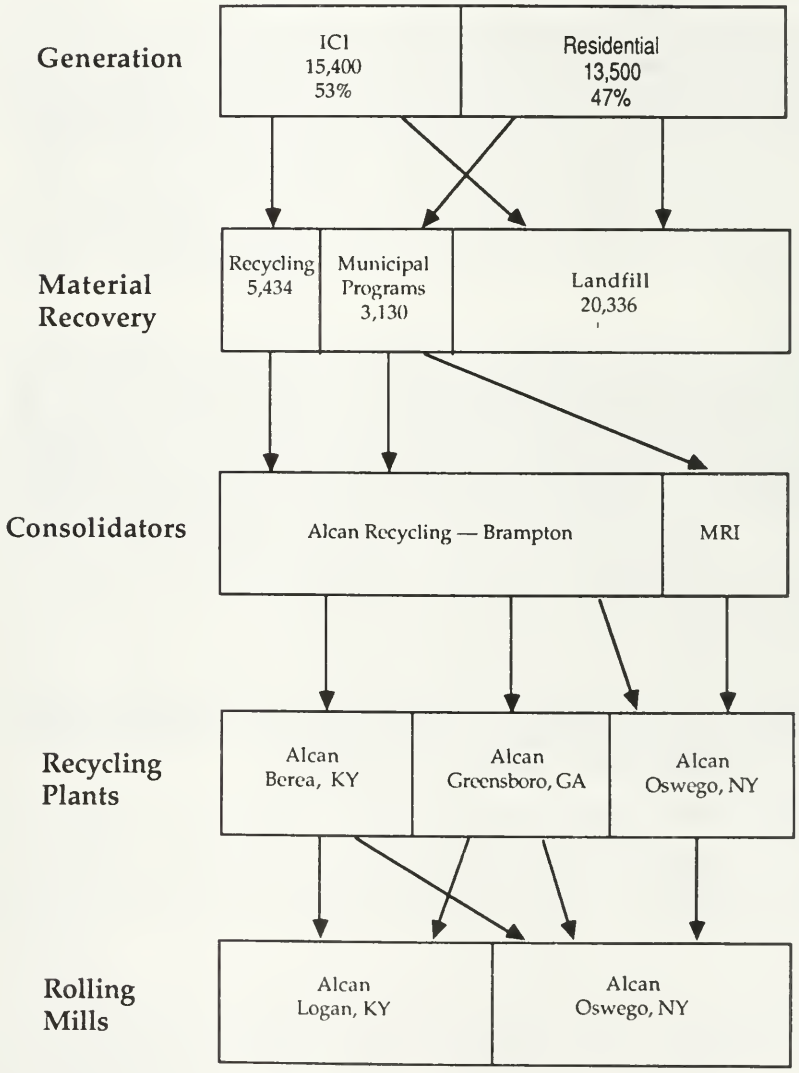
Up until 1990, Rosen Iron and Metal in Brampton was the major aluminum consolidator in the province. Rosen had a long term contract to process beer cans from Brewers Retail, and an agreement with Alcan to consolidate cans from curbside programs. Alcan purchased Rosen in 1990, securing most of the UBC recovered in the province. Previously, Rosen had split beer can sales between Alcan and Alcoa. The only other consolidator of UBC is Metal Recovery Industries (MRI) in Hamilton, which buys material from the Hamilton municipal recycling programs. MRI currently sells some UBCs Alcan, giving them 100% of the Ontario market. Volumes and prices were not available.

The newly named Alcan Recycling in Brampton buys used aluminum cans from municipal recycling program operators and from YV Recycling which operates a commercial sector can recycling service in Metro Toronto. Cans are baled at the Brampton facility and shipped by railcar to one of three Alcan recycling plants in North America -- Berea, KY, Greensboro, GA, and Oswego, NY. Some large municipal recycling facilities in Ontario ship truckloads of baled UBC directly to the Oswego plant as well. Sheet ingot from Berea and Greensboro is shipped to a rolling mill in Logan KY, while ingot from the Oswego plant is processed by a rolling mill at the same location. (Refer to Figure 12.1 for a summary of aluminum market activity).

Foil

The market for aluminum foil is secondary aluminum smelters which manufacture aluminum ingot for various applications. The Alcan smelter in Guelph is the only secondary smelter in the province.

Figure 12.1
Aluminum Used Beverage Cans (tonnes)
Ontario 1989



12.2.2 Factors That Effect Demand For UBC

The key factors that affect demand for UBC are:

- demand for can sheet
- cost of primary aluminum
- the price of UBC

Aluminum cans are a unique package because they are 100% recyclable and can be made of 100% recycled aluminum. Therefore used cans are a direct substitute for primary aluminum in the can sheet production process. Manufacturing cans from UBC is much less capital and energy intensive than manufacturing from primary material. According to Alcan, it requires $10,000 in capital costs to produce one ton of primary aluminum ingot, compared to $500 in capital costs to produce one ton of remelt ingot. In addition, production of remelt ingot only requires 5% of the energy needed to produce primary aluminum.[9] As a result, there has been a shift away from use of primary metal in can sheet manufacture towards UBC.

The price for UBC is typically set by the major aluminum companies, with the largest, Alcoa, usually taking the lead. Prices for UBC are generally $0.20 U.S./lb. below the price for primary ingot to account for transportation and a 15% melt loss factor.[10] Currently the price for primary ingot is in the $0.80 U.S/lb. range while UBC is at $ 0.56 U.S./lb.

12.2.3 Factors that Influence the Choice Between Primary and Secondary Materials

Table 12.2 shows that a can sheet ingot (an ingot is a mass of metal cast into a bar or other convenient shape) can be produced from UBC for approximately $0.77/lb., whereas a can sheet ingot can be produced from primary metal for $0.51/lb.

Table 12.2

Economics of UBC vs. Primary Ingot

UBC ($U.S./lb)	
Scrap metal	.56
Cost of 15% melt loss	.10
Transportation	.01-.02
Cost to transform into ingot (energy, labour)	.09
Net cost to buy and reprocess UBC	.76-.77
Primary Ingot ($U.S./lb)	
Alumina	.190
Energy	.138
Labour	.081
Alloys	.030-.040
Other	.067
Net cost to produce ingot	.506-.516

(Source: Resource Recycling, November 1989)

One would therefore expect that producers would prefer to use primary sheet ingots. However, primary ingot has a wide range of uses and can be sold for $.80/lb. on the open market. In contrast, UBC ingot usage is limited almost entirely to can sheet production. As a result, producers use the primary ingot for higher value applications and use the UBC ingot for can sheet production. However, when demand for primary ingot declines and prices fall, UBC prices must fall as well to stay economically viable. Conversely, when primary ingot prices rise, UBC prices must rise to keep cans from going to secondary smelters as a substitute for lower grade scrap such as siding.[11]

According to Alcoa, UBC prices have to be kept above $0.42/lb. to prevent buy back activity from drying up. At the high end UBC prices are constrained by the price of can sheet. Current prices for can sheet are in the $1.20/lb. range and the cost to convert ingot into can sheet is about $0.40/lb. Therefore, UBC could not rise above $0.60/lb. without becoming uneconomical.[12]

12.2.4 Price/Elasticity Analysis

Factors Affecting the Elasticity of Demand

Scrap aluminum is a substitute for primary aluminum, a commodity the price of which if determined on the world market. Prices paid for scrap aluminum cans (baled, delivered) have risen from $1,588/tonne in 1980 to $1,750/tonne in 1989. This gradual increase in real prices offered for scrap reflects the trend in the global market for aluminum over this period.[13] At present, used beverage cans (furnace ready) sell for about 70 per cent of the price of primary aluminum.

Energy is a large contributor to the variable cost of aluminum production. Waste aluminum requires very little upgrading prior to melting. New energy savings accruing to manufacturers by using scrap aluminum have been estimated to be about 95 per cent.[14] Capital costs associated with processing primary aluminum *versus* secondary aluminum vary as well, with the former reported to be higher than the latter by a multiple of 20. These savings are considered large enough to virtually guarantee the market for recycled aluminum at relatively high prices. Like all other potentially recoverable commodities however, contamination can cause processing problems, so contaminated loads often garner lower than market prices or are rejected altogether.

The market for recycled aluminum in Ontario is dominated by a single buyer, Alcan Rolled Products Company. The firm is fully capable of absorbing all potential supplies of recyclable aluminum in the province. Even very high rates of recovery, coupled with consistent growth in aluminum consumption, should not affect prices paid to municipalities. The only source of problems in finding markets for recovered aluminum is the potential for world prices of aluminum to fall, which can be expected in the event of an overall decline in worldwide economic activity.

Factors Affecting the Elasticity of Supply

The quantity of aluminum beverage cans consumed in Ontario has been increasing since the ban on their use in the soft drink manufacturing industry was lifted in 1987. Aluminum now accounts for approximately 65 per cent of the market for soft drink containers. The market is, however, in a state of flux. One major bottler has decided to switch containers from aluminum to steel, and two major bottlers are embarking on a program to encourage customers to purchase soft drinks in glass bottles rather than cans.

It is difficult to predict the marketplace even two to three years ahead. These events have a bearing on municipal blue box programs, primarily through the different prices offered for the alternative container materials, aluminum

being the highest by weight. In addition, other container materials weigh more than aluminum per unit volume of beverage content. To the extent that aluminum is displaced by other materials then, the overall mass of the waste stream will increase. The pertinent factor to long run landfill costing is volume, however, and waste volumes will increase or decrease depending on the rates of recovery pertaining to glass and steel containers.

The elasticity of aluminum supply from private voluntary recyclers has been estimated to be relatively high: 1.1 to 4.3.[15]

The elasticity of aluminum supply from municipal recycling programs is relatively high in comparison with other blue box commodities: 0.73.[16]

12.3 Market Potential to Absorb Supply

North American UBC recycling plant capacity is expected to expand by 73% over the next two years to accommodate the increased need for UBC in the production of can sheet.[17] With the opening of its Berea plant, Kentucky, U.S.A., in 1989, Alcan alone has doubled its UBC capacity to 240,000 tonnes per year. This increased capacity, combined with the decreasing levels of aluminum soft drink cans in Ontario means that market capacity will be more than adequate to absorb the estimated 6,900 tonnes of UBC projected to be recovered annually in Ontario by the year 2000. Since there are no recycling mills for UBC in Ontario, all of it is eventually sent to Alcan recycling plants in the U.S.

The small quantities of aluminum foil that will be generated by Ontario recycling programs are a minor portion of total scrap demands at the Alcan Guelph smelter and can be easily accommodated.[18]

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13.0 ORGANICS

13.1 Supply

Historically, food and yard waste has accounted for about one third of all residential waste and roughly one sixth of the industrial/commercial waste stream. Thus, compostable materials represent one of the largest single components of the municipal solid waste stream. The initiation of a full scale composting program across the province will inevitably be a major component of any strategy designed to achieve proposed short and long term diversion targets.

13.1.1 Generation by Sector

Current Generation

The current generation of food and yard waste in Ontario is, as stated above, about one third of the residential waste stream. Specifically, CH_2M Hill's percentage estimates for organics in the residential solid waste stream in 1989 are shown on Table 13.1.

Table 13.1

Estimated 1989 Residential Organic Waste Generation in Ontario

Residential Organic Fractions	Percent	Est. Tonnages/Year *
Food waste	15.41	624,600
Yard waste (leaves, grass & weeds)	12.08	489,500
Other yard waste (pruning, brush...)	4.07	164,900
Totals	31.56%	1,279,000

* These 1989 tonnages are based on an 1989 Ontario population of 9,598,600 and a generation rate of 422 kg./capita/year, both provided by CH_2M Hill.

From the data above, generation of organic waste in the residential sector is 332 kg/household/yr.[1] In Mississauga, where organic waste collection has been closely monitored for 1,200 households, the average quantity of organics collected from June to December 1989 amounted to 390 kg/household/yr. When this is adjusted to reflect the seasonality of yard waste, it is close to the CH_2M Hill data for Ontario organic generation in the residential sector.

CH_2M Hill has estimated that there are 600,000 tonnes of organics in the ICI waste stream for 1989. However, CH_2M Hill has not provided detailed composition data on the organic fraction. Therefore, RIS has estimated yard and food waste based on Seattle waste composition data. The results are documented in Table 13.2.

Table 13.2

Estimated 1989 ICI Organic Waste Generation in Ontario

ICI Organic Fractions	Percent	Est. Tonnages/Year
Food waste	8.25%	490,000
Yard waste (leaves, grass & weeds)	1.01%	60,000
Other yard waste (pruning, brush...)	0.84%	50,000
Totals	**10.10%**	**600,000**

If ICI solid waste is generated at 550 kg/capita/yr then, in terms of volume, the organic fraction represents 77 kg/capita/yr or 194 kg/household/yr.

Projected Generation

Factors affecting the generation rates of food waste are related to population increases in **1992** and **2000.** Therefore, projected tonnages are based on 1989 per capita generation rates and subsequent increases in population. Yard waste generation is affected by garden and yard maintenance practices in part. For example, frequency of lawn cutting, collection of grass clippings and use of specialized mulching mowers. However, it is uncertain as to how widespread these kind of practices will be in the future. Therefore, as above, future yard waste generation rates have been projected based on 1989 per capita rates and subsequent increases in population.

Table 13.3 summarizes projected data for each of the three benchmark years for both sectors.

Table 13.3

Estimated Ontario Generation of Organic Waste for Residential & ICI Sectors in 1989, 1992 and 2000

Residential Organic Fractions	1989	1992	2000
Food waste	624,600	651,733	708,569
Yard waste (leaves, grass & weeds)	489,500	510,897	555,452
Other yard waste (pruning, brush...)	164,900	172,132	187,143
Totals (in tonnes)	1,279,000	1,334,762	1,451,164

ICI Organic Fractions	1989	1992	2000
Food waste	490,000	512,000	557,000
Yard waste (leaves, grass & weeds)	60,000	62,000	68,000
Other yard waste (pruning, brush...)	50,000	52,000	56,000
Totals (in tonnes)	600,000	626,000	681,000

13.1.2 Current and Projected Diversion Levels

Current Diversion

Backyard Composting

Current composting activity in Ontario is limited to the municipal distribution of backyard composters and yard waste composting programs. While exact figures are presently difficult to ascertain, an estimate regarding the number of backyard composters installed in 1989 is possible.[2]

It is estimated that 39,480 backyard composting units were active in 1989. The waste diversion potential of backyard composters is largely unknown; however, a study involving 100 households in the Region of Durham was recently completed by Compost Management.[3] While the field evaluation covered September through December 1989 only, it does represent a first attempt to quantify the impact of this waste reduction measure.

Based on the experience gained in Durham, it is estimated that an average year round diversion of 240 kg/year per household or, more specifically, per composting unit, might be a reasonable figure to assume. It is assumed that

approximately 75% of the organic materials composted at home is food or kitchen waste.

Metro Toronto leads the backyard composting effort with over 20,000 units, followed by the Regions of Waterloo and Peel, and the City of Guelph in Wellington County. The number of units per area is multiplied by the estimated diversion factor of 240 kg/yr for a projected tonnage figure. In 1989 waste diversion is estimated to be 9,475 tonnes of yard and food waste.

Yard Waste Composting

Yard waste composting activity is occurring in a number of communities particularly in the more populated regions of Southern Ontario.[4] While the primary focus is still leaves, both Metro Toronto and Waterloo are collecting and composting grass clippings and chipped brush is being handled in Metro, Fort Erie, Markham and Oakville. Because of its size, Metro Toronto is collecting and composting the largest quantity of leaves in the province. Collection techniques vary from vacuum trucks to residential curbside collection of bagged leaves.

Within each region or county, only those cities and towns with leaf composting programs were counted. For those programs where reported tonnages were unavailable, a capture rate of 20% of all leaf waste material generated in that particular community is assumed. A higher capture rate might be justified in the absence of backyard composting activity. However, there is a lack of data concerning the "fit" between curbside collection of organics and home composting and what respective captive rates might be. The following formula is used;

no. of hhlds. served X local population density X RSW gen. rate X RSW leaf percent* X capture rate ÷ 1,000 kg. = estimated tonnes of leaves composted.

*It is estimated that about two thirds of residential yard waste are leaves. If 12% of residential solid waste is yard waste, then 12% X 2 + 3 = 8%.

For example, in Ottawa: 122,000 hhlds. served X 2.45 people/hhld. X 422 kg./hhld./yr. X 8% leaves X 20% capture ÷ 1,000 kg. = 2,018 tonnes of leaves. Thus, in 1989, total residential yard waste composting is estimated at 38,764 tonnes.

Wet/Dry

Wet/dry refers to a specific collection/processing waste management system practised in some communities in Europe and now being pilot-tested in

Canada. In these programs, residents are typically required to source separate their refuse into two, three or even four streams. For example, two stream system would have one stream containing dry waste materials while the second stream would have wet or organic waste materials. The wet stream can be composted. The introduction of wet/dry systems will involve curbside collection of food and yard wastes and centralized composting facilities.

There was minimal activity in this area in 1989. The Cities of Guelph and Mississauga began pilot programs involving approximately one thousand households in total. (The Towns of Powell River, BC and Ryley, Alberta have curbside collection of organic materials as well).

ICI Composting

The recovery of organic solid wastes from the ICI sector is more difficult to determine. It is probably safe to assume that very little is currently being done in this sector since there are very few large scale, centralized composting operations anywhere in the province. The only exception is the Region of Waterloo which now takes in leaves from the ICI sector and will take grass in 1991.

Projected Diversion

Backyard Composting

The increase in composting activity is expected to be great especially in Southern Ontario where landfill siting pressures are most acute. Backyard composters will continue to be popular with municipalities given their relatively low capital and operating costs. Discussions with MOE officials indicate that applications for 200,000 units are now being considered for funding.[5] Based on the availability of Ministry funds, it is estimated that 80,000 composters will be installed each year until the year 2000. For the sake of projections, it is assumed that 240 kg/household/yr will continue to be the recovery rate.

Yard Waste Composting

Separate yard waste collection and composting efforts are also expected to increase through 1992 and on to 2000. While there is some reason to be concerned about the incompatibility of yard waste collection and backyard composters, assumptions about the recovery rates for each measure result in total recovery rates that are less than total organic generation rates.

Wet/Dry

The growth of wet/dry systems in Ontario is at this time uncertain. Several communities are interested in wet/dry systems such as the Regions of Halton and Waterloo, and the Cities of Kingston, Lindsay, Peterborough and Stratford. Imminent widespread implementation of wet/dry systems is not yet anticipated given their high capital and operating expense in the order of 30 to 40% increase in costs over and above conventional blue box landfill waste management system.[6] These systems will however become more attractive to municipalities as the costs of landfill disposal continue to increase.

In order to make some projections on the level of recovery through future wet/dry efforts, the quantity of organics collected in the Mississauga pilot discussed above (390 kg./household/yr.) is applied against a small percentage of households (say 5%) in communities where it is estimated that wet/dry activity in 1992 will be focused: Metro Toronto; the Regions of Durham, Halton, Hamilton-Wentworth, Niagara, Peel and York; the Counties of Essex, Peterborough and Wellington. For the year 2000 projections, the average size of these programs is assumed to grow to 15% of all households. Also, new wet/dry efforts are anticipated in Ottawa-Carleton and Waterloo.

ICI Composting

Metro Toronto plans to collect food waste from 12,000 restaurants by the year 2000 to be composted at the Downsview plant (previously this was a resource recovery facility) after it has been fully converted to a composting operation.[7] Other than this estimation from Ontario's largest regional municipality, projections for other communities are difficult to make since their plans for this specific part of the waste stream are, for the most part and with very few exceptions, still in the development stages.

In addition to Metro Toronto, by 1992, it is expected that ICI composting will be limited to activities in the Regions of Peel and Waterloo and the City of Guelph.

Current trends suggest that communities across Ontario will become more restrictive in terms of what can or cannot be landfilled. It is possible that materials that can be recycled or composted will actually be banned from landfill disposal.

ICI Food Waste as Animal Feed

Discussions with the Ministry of Agriculture and Food suggest that the current level of diversion of ICI food waste to Ontario hog farmers is approximately 30,000 tonnes per year.[8] Due to stringent public health regulations, this level is expected to remain constant. Therefore, the 1989 diversion rate of 30,000 tonnes/year is the estimate used for 1992 and 2000.

Food processing wastes (particularly those wastes that are dry) are also fed to beef cattle, however, this is done on an *ad hoc* basis and estimates are not available.[9]

Table 13.4 summarizes projected diversion data for each of the three benchmark years for both sectors. A distinction has been made between food and yard wastes.

Table 13.4

Estimated Diversion of Organic Waste for Residential & ICI Sectors for Ontario in 1989, 1992 and 2000 (tonnes/year)

Residential Organic Fractions	Proportions	1989	1992	2000
Backyard composting	75% food	7,106	50,400	115,200
	25% yard	2,369	16,800	38,400
Yard waste composting	100% yard	38,764	128,342	374,930
Mixed organic composting	50% food	0	14,427	50,120
	50% yard	0	14,427	50,120
Totals (in tonnes)		**48,239**	**224,396**	**628,770**

ICI Organic Fractions	Proportions	1989	1992	2000
ICI composting	100% food	some	65,450	129,768
ICI waste as animal feed	100% food	30,000	30,000	30,000
Totals (in tonnes)		**30,000**	**95,450**	**159,768**

13.1.3 Potential for Increased 3R's Activity

Reduction

In addition to the composting activities indicated above, further efforts to reduce the amount of organics entering the waste stream can be stimulated through the promotion of efficient yard management practices (for both resident and parks maintenance) that do not generate waste. That is, do not rake grass up; rather, leave it on the lawn as a natural mulch. Or, plant slow growing evergreens that naturally do not generate as much organic waste as other plant groups. While it is difficult if not impossible to measure the waste impact of these kinds of activities, they are nevertheless significant in terms of public education.

Reuse

The second R does not apply in the case of residential food and yard waste. Backyard composting could be interpreted as "reuse" in the sense that kitchen and yard wastes are reused as compost in the garden.

Recycling/Composting

The third R refers to composting and has already been discussed at length throughout Section 13.0. The potential for increased activity in this area is high given (1) the province's commitment to achieving its ambitious waste diversion targets and (2) the relatively large percentage of the waste stream that is organic (and therefore compostable) in nature. The Minister of the Environment recently announced (February 21, 1991) that mandatory source separation of waste materials in the ICI sector is being considered as a measure by 1992. As a result, it is likely that composting of ICI food and process wastes in particular will become increasingly more common as an effective waste reduction activity throughout the province.

13.2 Demand

13.2.1 Market Structure

There are a variety of end uses for finished compost. However, many of these markets in the Ontario context must be considered as potential rather than actual given the current state of composting in this province. In other words, since composting as a waste management tool is only now emerging as a possible alternative to landfilling, this particular market is still in its infancy.

In most urban areas, the wholesale and retail markets for soil products are fairly complex: There are producers or processors, retailers, commercial

growers, and institutional, commercial and residential users. Since composting is not yet a widespread activity in Ontario, the identification of users for end products will be a gradual task but must be initiated as soon as possible in order to acquaint potential users with anticipated programs and the products.

Compost Flow Chart

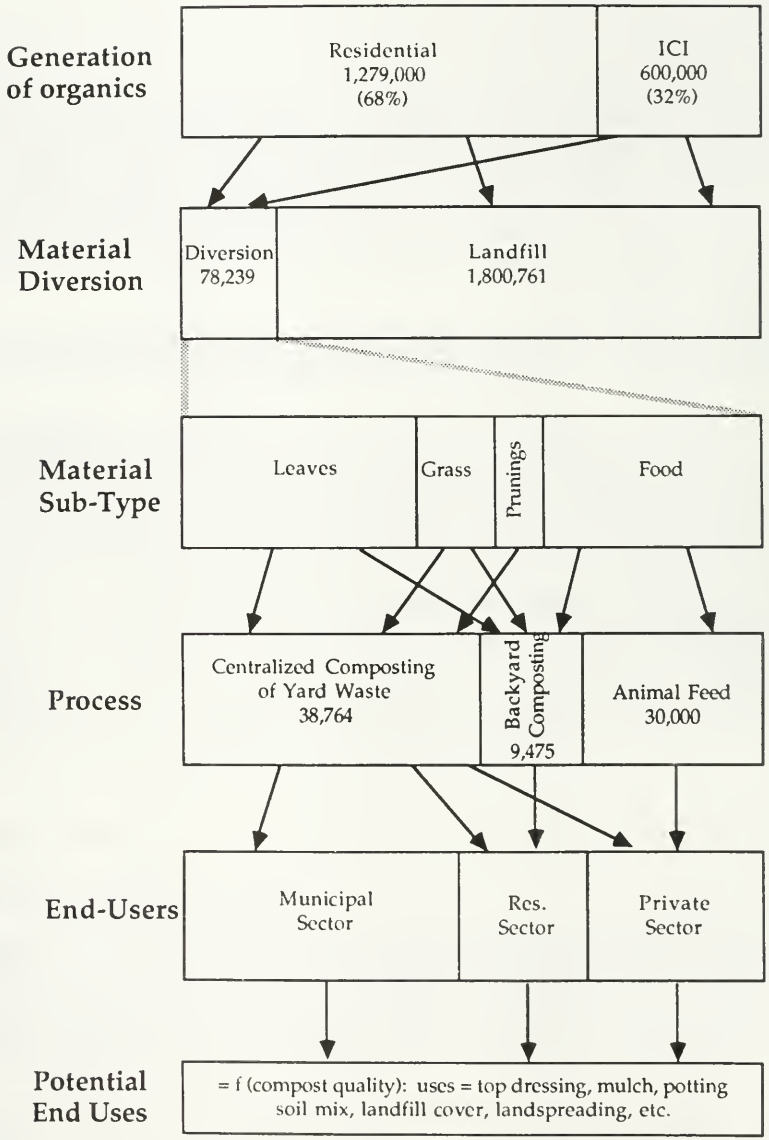
Figure 13.1 attempts to model the current flow of organics in Ontario. The split between residential and ICI organics is derived as noted previously. What is presently recovered results from three primary activities: backyard composting, yard waste collection and composting, and food waste as animal feed. The latter is not, as described above, composting *per se* however it does represent a destination for organic waste other than the landfill and as such is included in the chart. A discussion of the limits of food waste as animal feed is provided in Section 13.3.

As illustrated in Figure 13.1, the vast majority of organic materials (97.6%) end up in landfills.

The composition of materials currently recovered is unknown. Figure 13.1 attempts to give proportional representation to the quantities diverted. Centralized composting receives yard waste mostly, especially leaves and grass with some pruning as well. Backyard composters potentially can receive any of these materials depending on the enthusiasm of the householder.

Figure 13.1 provides a summary for Ontario markets for Organics.

FIGURE 13.1
Organics (tonnes per year)
Ontario 1989



Compost Players

The players involved in composting reside in all three sectors of the economy: public, private and residential. In terms of relative quantities, the former two are of greatest significance. Since solid waste disposal is a municipal responsibility, public works departments across the province are becoming increasingly involved with leaf composting. Other municipalities contract out this work to a growing number of private firms that offer leaf and yard waste composting services.[10]

Many of these firms are fully integrated in the sense that they produce other soil amendment products that include manure, sawdust, peat and sand. These firms sell their products to a variety of retail and wholesale consumers. Municipalities producing leaf compost, for example, are both producers and consumers of the compost material. They may also give or sell the compost to the general public.

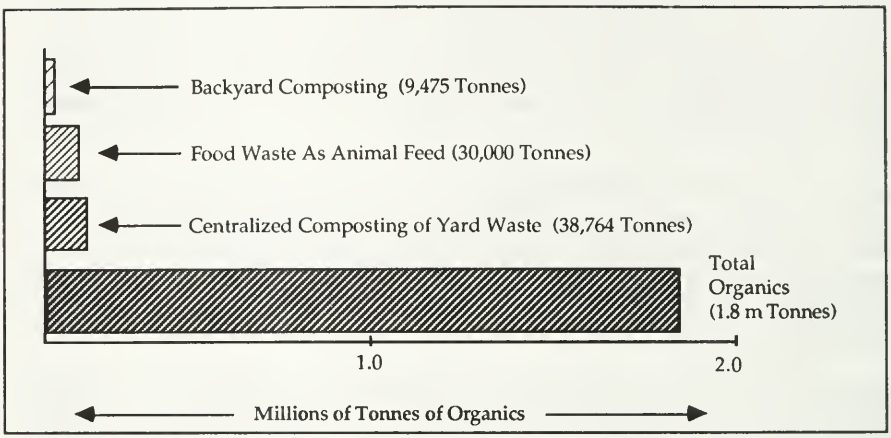
Actual and potential end users can be divided into three general sectorial groups as shown in Figure 13.1; municipal, residential and private. The residential sector receives an amount of compost greater than that which would be generated through backyard composting activities since a number of municipalities are giving finished compost away. This implies that there is residential demand beyond backyard composting supply. In certain cases the compost produced in residential backyards replaces peat moss and potting soil purchases.

Levels of Activity

Current levels of effort are low compared to potential activity. Figure 13.2 attempts to show the gap between what is diverted from the landfill and what is not. Clearly, the amount of organics remaining to be collected, processed and marketing is enormous.

Figure 13.2

Generation & Recovery of Organic Wastes in Ontario – 1989


Backyard Composting (9,475 Tonnes)
Food Waste As Animal Feed (30,000 Tonnes)
Centralized Composting of Yard Waste (38,764 Tonnes)
Total Organics (1.8 m Tonnes)
1.0
2.0
Millions of Tonnes of Organics

Source: RIS Ltd. 1990

As stressed at the outset, composting is becoming increasingly popular as an effective waste reduction activity with great implications for the whole waste management system. Major growth is expected in centralized composting of leaves and in the distribution of backyard composting units. The potential growth of the use of food waste as animal feed is less certain.

There is no information available on compost processing capacities in Ontario.[11] Metro Toronto recently doubled its quantity of composted leaves from 6,000 tonnes to 12,000 tonnes by promoting the separate collection of leaves more aggressively to the general public. Metro has plans to compost 60,000 tonnes of leaves each year by 1992.[12] Theoretically, it should be possible to compost all the leaves in Metro given the available space in which to do it (~8,200 square metres needed to accommodate ~6,000 cubic metres of collected leaves).[13] Composting operations can be conducted both outside (e.g. windrows) and indoors (e.g. in-vessel).

As presently demonstrated in those communities in Ontario where some composting is already occurring (e.g. Ottawa, Oakville, Markham, etc.) municipal users (e.g. Parks & Recreation, Roads, Public Works etc.) of compost represent initial points of consumption. This is particularly the case since such users – including other public and private institutions – do not require the highest quality product given their expected low level use of the material (i.e. landscaping, turf maintenance etc.).

Discussions with municipal officials who operate their own leaf composting programs indicates that supply of compost is still short of internal demand.[14] In the case of Metro Toronto, the demand for compost in the Roads, Parks and Property Departments currently exceeds supply.[15] Nevertheless, the Metro Works Department also has plans to give the compost away to residents, perhaps even to non-profit housing developments,[16] probably as a public relations measure.

Potential Levels of Activity

Experts in the field believe that composting will become most viable in the long term with the establishment of stable *public sector* markets.[17] Potential uses include,

- restoration of derelict public lands
- maintenance programs for parks and recreational areas
- various municipal landscaping projects
- erosion control programs
- highway noise reduction barriers

Further, legislation in California requires that each jurisdiction describe the methods by which it will help develop market demand for compost products.[18] Such methods may include measures that favorably price compost over competing products or facilitate amendments to product specifications that encourage the use of compost products. California's position is that the private sector market for compost is not large enough to absorb that which is potentially available. Given their more advanced state of composting, Californian efforts are worth monitoring for possible adoption in Ontario.

In the *private sector,* agricultural businesses requiring soil-amending products include the following (and note that corresponding compost demand for each farm type is unavailable):

Table 13.5

Potential Agricultural Markets for Soil-Amending Products

Potential Ontario Market	Number of Sites	Total Acreage
nursery farms	819	14,726
sod farms	115	8,178
flower farms	1,042	483
vegetable farms	913	352
mushroom houses	55	87
other greenhouse products	150	29

Source: Statistics Canada, 1986 Census of Agriculture – Ontario, 96-108, Table 5

Demand is related to whether or not municipal compost can meet the standards established by the MOE which have not yet been finalized (i.e. there is concern for the potential presence of heavy metals in compost). As well there are other factors related to demand which will determine use of compost:

- their relatively isolated locations;
- their specialized technical requirements; or
- their lack of information/interest concerning compost.

In addition to the farms listed in Table 13.5, the majority of farms grow more traditional crops such a grains, beans and maize. Altogether, in the Province of Ontario there were 8,446,307 acres (or 3,418,220 hectares) carrying major agricultural crops in 1986.[19] Compost could be beneficially applied to any farmland as is now done with some sewage sludge. An application rate in the order of 20 tonnes of compost/hectare/year is a conservative estimate.[20] At that rate, 68 million tonnes of compost could be spread on agricultural land each year which is much more compost than can be produced in this province.

Another potential market for compost is the local golf course. In Ontario there are 545 golf clubs occupying 59,840 acres of land (courses only). According to the Canadian Golf Foundation,[21] golf courses apply top dressings in one of three ways on tees, fairways and greens:

Table 13.6

Composition Analysis of Top Dressing for Canadian Golf Courses

Top Dressing	Tees	Fairways	Greens
sand	31.5%		37.7%
sand + peat (60/40)	46.3%	100%	52.5%
sand, peat + soil (60/20/20)	22.2%		9.8%
No. of applications/year	2.7	4.7	3.0
Approx. size of application	1 cu. yd.	10 cu. yd.	1 cu. yd.

Source: Canadian Golf Foundation, 1990

Since compost is not a substitute for sand, which is applied more for drainage purposes than as a soil enhancement, the following calculations concern peat and soil. Assuming that the densities for peat and soil are 843 and 1,674 pounds/cubic yard respectively,[22] the total quantities of materials used for turf maintenance on Ontario golf courses are estimated to be 61,000 tonnes of peat and 1,100 tonnes of topsoil per year.

Potentially therefore, if compost can compete with peat and topsoil in a qualitative and in an economic sense – and gain acceptance from golf course maintenance supervisors – then the potential market is reflected in the figures above (62,100 tonnes in total).

Finally, residential demand for compost is largely unknown. Recent experience concerning the "give-away" of backyard composters in communities throughout Ontario would suggest that the public response to free or very cheap compost will be just as favorable (20,000 units claimed by Metro residents before promotion of program two years in a row).

In Brookhaven Township, New York, area residents have been obtaining (for free) 20,000 cubic yards of municipal compost for home use each year. This equates to 44 lbs/household/year or 20 kg/household/year (Brookhaven Township has 450,000 inhabitants. One cubic yard of compost equals half a tonne of compost).[23] Assuming the same kind of demand for compost in Ontario by each blue box household in 1989 (two million households), 40,000 tonnes/year of compost could be absorbed by this potential market.

13.2.2 Factors That Influence Demand

There are a number of factors that affect the demand for any given material. In the case of compost, the following factors are of significance[24];

- product quality
- reliability of supply
- product price
- price of competing products
- local demographics/economics
- distances between market and user
- local building/development activity
- advertising/public information
- provincial/municipal regulations
- previous experience with compost (good/bad/none)

Product Quality

The quality of compost is of the utmost importance. Unlike some of the other recyclables considered in this study, compost is extremely complex in character. Compost marketability is affected by its physical, chemical and biological characteristics. For example, consider the many combinations of moisture, particle size, color, odor, maturity, nutrient levels etc. that can distinguish one batch of compost from another. Large-scale consumers of compost require a product (or perhaps several distinct products) that has a consistent and reproducible reputation.

As described in the first interim report, measurable undesirable contamination of compost will quickly kill demand for that product, in many circumstances, for some time. Consider the consequences of a sod farmer laying down compost that has live weed seeds.

Reliability of Supply

As with the quality of compost, it is essential for producers of compost that they provide a continuous flow of material in order to effectively compete in the marketplace. Composting yard waste on a year round basis in Ontario is difficult given the four seasons. However, once mature, compost can be stored for an infinite amount of time and thus sold throughout the year. It should nevertheless be noted that demand for compost-type materials is greater in the spring when gardens are planted and prepared for the growing seasons. The fall is also an important season for gardeners.

Product Price/Competing Products

As with most other materials, the demand for compost or other soil amendments is related to its price. Pricing competing products is difficult however because of the varying mixes of materials required by users. For example, sod farms may not have the same demand for high quality topsoil as a nursery that raises exotic flora for retail to the general public. The sod grower's requirements may be satisfied by mixing manure with sawdust whereas the nursery will have to purchase screened topsoil.

Discussions with the National Sod Growers Association of Canada suggests that typical sod farmers are not interested in using compost at all. Further discussion with a sod farmer suggested otherwise; that is, if compost could add nutrient value to the soil, be economically attractive and be easily applied, it would be considered as a soil amendment.[25] Such conflicting views suggest that the value of compost is not widely known among potential end users of compost and that therefore promotion and education will be required to develop this market further.

The relationship between demand and price is obviously very close. In particular, the price charged for compost will be directly influenced by the following factors[26]:

- supply and demand
- compost quality
- the price of competing products
- production costs
- research and development costs
- marketing costs
- bulk purchasing
- user experience/attitude towards the product

Some of the above factors have already been mentioned as influences on demand but are reiterated here as having specific impacts on the pricing of compost *per se*. Interestingly enough, experts in the field recommend that compost not be given away for free since the user will place little value on the material, thus making it more difficult later to set a price.[27]

The transformation of yard waste materials into compost on a large scale has just begun in Ontario. As a means of diverting waste from landfill, composting has tremendous potential whether the product is sold or given away. The development of composting as a cost-effective waste management activity is currently not predicated on its revenue-producing ability.[28] Indeed, it is also possible that the net cost of composting will be low enough that revenues will not be critical at all.

As mentioned earlier, compost could be treated like sewage sludge which is hauled from treatment facilities to farmland and applied at municipal expense.

Table 13.7 compares the market price of two compost products with other competing soil amendment products.

Table 13.7

Compost and Competing Product Prices in Ontario (per cubic yard)

Material	Wholesale Price	Retail Price
COMPOST		
Grow-Rich Compost	$5-30	$99
Markham Leaf Compost	na	$21
NON-COMPOST		
Screened Top Soil	$12-37	$65-85
Peat Moss	$35	$61
Cattle Manure	$43	$94
Triple Mix (peat, manure & soil)	$35-43	$87-150
Wood Chips	na	$94
Mulch (cedar)	$41-47	$120

Source: Grow-Rich, White Rose Nurseries, Sheridan Nurseries, Weall & Cullen, Humber Nurseries and CMA, 1990.

The above table indicates that compost from municipally collected leaves (i.e. Markham) is priced considerably lower than competing products.

Distance Between Market and User

Transportation costs are a significant factor in determining both the price that compost can be sold at and subsequently the demand for it. Composts are typically bulky in nature and therefore substantial expense may be incurred when shipping the product to market.

According to one study which surveyed topsoil dealers and hauling firms in the Minneapolis area, compost type materials cannot economically be shipped more than 48 km.[29] The significance of this finding is that markets for compost necessarily become local in nature with two results: limited market size and limited competition. This also suggests possible benefits associated with constructing smaller-scale composting facilities; that is, a smaller (i.e. closer) market area will be needed to serve smaller plants.

Local Demographics/Economics & Local Building/Development Activity

Since demand for compost is likely to be local due to the high cost of transport, the economic health of any given community is just as likely to affect demand for compost as other products. A correlation may exist, for example, between the value of housing and the demand for landscaping materials. It has been found that communities or neighborhoods which are more affluent recycle more or are at least more environmentally aware.[30] This segment of the population therefore represents a potential market for "green products" such as compost.

Communities that are expanding and developing always require large quantities of landscaping materials. Such activity will greatly influence the demand for compost-type materials; however, cost and availability of the product will determine whether these users are repeat customers.

Advertising/Public Information

Public education and promotion are extremely important in creating awareness of the availability and understanding of the value of a product such as compost. A rise in the demand for compost will be commensurate with a widespread belief that it is a safe and viable substitute for the other soil amendments (i.e. competing products) mentioned above.

Provincial/Municipal Regulations

Finally, regulations affecting the production and marketing of compost must be recognized for the influence they have on demand. Most regulations pertain to compost quality and standards, facility siting and approvals, and public health and safety factors.[31] Ontario has internal guidelines on composting which are used for approval purposes only. The Ministry of the Environment is presently developing a new, more comprehensive set of guidelines for public release. It is likely that explicit regulations will result in increased composting activity in Ontario at both a municipal and commercial level which will, in turn, positively influence the supply of compostable materials.

Further, provincial/municipal regulations regarding preferential procurement practices would help establish increased demand for compost over other purchased soil products. The impact of such a measure is related to the amount of government construction activity underway (likely to be significant at any time).

Previous Experience (Good/Bad/None) With Compost

As with the potential consumption of any product, prior experience with the item will strongly influence the decision to be a repeat customer. Positive past experience will very likely result in continued patronage. On the other hand, negative experience from previous purchases will cause that person to shop elsewhere for an alternative product. This discussion relates directly to the one above on product quality.

13.2.3 Factors Affecting Choice Between Primary and Secondary Materials

At the retail and wholesale level, compost has to compete with a number of other products that have been widely available for some time. These products are as follows;

- topsoil
- peat moss*
- manure
- triple mix - combination of the above three
- mixed humus
- mixed mulch
- wood chips
- sawdust

*According to the Ministry of Agriculture and Food, 3.3 million tonnes of dry peat are consumed in Ontario each year.[32]

The other product which may be perceived of as a competitor to compost is commercial fertilizer. The size of this particular market in Ontario is 553,700 tonnes per year.[33] It should be recognized however that compost is not fertilizer; rather, it is a soil amending or enhancing product which improves tilth (tilth is the physical condition of a soil as it relates to plant growth). For the purposes of this study, therefore, fertilizer is not considered as a competing product.

Screened topsoil is the product to beat. Topsoil in a rougher form is readily available in communities where there is any kind of development at all.[34] This is particularly the case in the Greater Toronto Area. Discussions with various municipal officials reveal the following demand levels for screened topsoil and peat:

Table 13.8

Municipal Topsoil and Peat Use (a small Ontario sample) — 1990

Municipality	Population	Size	Topsoil/year	Peat/year
St. Thomas	28,405	4,487 acres	152 tonnes 34 kg./acre	na
Stratford	26,078	5,024 acres	304 tonnes 61 kg./acre	19 tonnes 3.8 kg./acre
East York	94,497	5,335 acres	1,579 tonnes 296 kg./acre	38 tonnes 7.1 kg./acre

Source: Personal communication with municipal officials (cost of topsoil and peat were not available as separate municipal budget items)[35]

Using either per population or per acre bases to extrapolate topsoil usage for the whole province would be misleading given the disparate nature of the province's municipalities in terms of their size, population, urban/rural makeup, location and economic activity (etc.).

Based on experience elsewhere, composted yard waste can displace a certain proportion of municipal topsoil demand particularly where cost savings are involved. Any compost that is left over after area municipalities and residents have taken all they want, is applied to the Region of Waterloo's landfill as the daily cover. Discussions with the Parks Department in St. Thomas indicate that they compost the leaves they collect in the local parks and then re-apply them to the gardens.[36] The compost would never completely replace top soil but makes it go farther as the two can be mixed together.

In Ottawa, parks officials believe that they could use ten times more compost than what is currently being produced (about 1,000 cubic meters).[37] Their decision to utilize the compost is obviously influenced by its availability. It would be interesting to know what the Parks Department demand for compost would be if they had to purchase it.

Many other communities are simply giving the compost away to residents under the premise that they have already paid for the composted material through their taxes (e.g. Region of Waterloo). There is excellent promotional benefit in having residents enjoy some return for their efforts. The impact of the give-away program on the market value of compost is unknown. However, from an earlier discussion it should be noted that the impetus to

initiating composting activity in this province is not necessarily a revenue-driven one.

The Region of Waterloo succeeded lately in giving away 2,140 tonnes of composted leaves within two days to area municipalities who simply carted the material back to their public works yards.[38]

In the private sector, conversations with the National Sod Growers of Canada, Brouwer Sod Farms, Landscape Ontario, Ontario Flower Growers Cooperative, a Metro Toronto golf course, Ravine Mushroom Farms and others suggest that the current market for composted leaves – all things considered – is generally not that great. Unfortunately it is difficult to determine even their present use of materials.

Some private soil product producers would like to receive municipally collected leaves for free (or even charge a tipping fee) so that they can process them for markets which they have already cornered with competing products.[39] Their decision to use compost over a primary material is, as mentioned above, influenced by its quality and by its price, especially the former. In the absence of an extensive survey, it is exceedingly difficult to quantify the actual demand that compost materials might enjoy from these users (but see following section).

13.2.4 Price/Elasticity Analysis

No highly developed markets exist for organic compost (as mentioned previously, municipal projects producing compost have made the product available free of charge), and no estimates of price elasticities of supply or demand are available in the literature. A single private producer of bagged and bulk compost operates in Ontario. Their product sells at retail or 99/cubic yard wholesale price ranges between $5 and $30 per cubic yard.

It has been estimated that between 150,000 and 300,000 m^3 of compost could be absorbed by Ontario municipalities and private sector agricultural operations, golf clubs and landscaping firms.[40] (Both of these estimates were derived from surveys. It is not clear whether respondents were asked for their estimate of potential consumption without regard to price). The potential supply of compost from municipalities could easily meet this level of demand.

13.3 Assessment of Market Capacity to Absorb Supply

In previous sections, research into actual and potential markets for compost materials has revealed a dearth of information concerning the current use of products that compete with compost. An assessment of the markets' ability to absorb large quantities of compost is hindered by this lack of data.

Potential end users of compost are most concerned about the quality of the materials. It must be free of various elements including weed seeds, heavy metals and other foreign bodies, have a soil-like appearance, and have a somewhat consistent particle size (although such requirements will vary according to user). Formal interest in compost (i.e. a commitment to purchase) would likely be preceded by sampling and testing the product over some time.

The three sectors (public, private and residential) considered during the research suggest tentative interest in compost material is dependent on its quality, price, availability, reliability of supply and form (bags or bulk). No potential end user would or could specify capacities or potential demand for compost.

In a more extensive survey process, the University of Minnesota asked 1,300 potential users of compost what their chief concerns were and how much compost would they use.[41] Sixty-five percent of respondents indicated that they would be willing to use compost in their operations. The range of this demand from all three sectors (residential, public and private) was from one to several cubic yards/year/user.

In total, the University of Minnesota estimated minimum potential demand for compost at 65,771 tons per year (with the equivalent amount of yard waste being 131,542 tons) in an urban area that holds 1.99 million people. This works out to 33 kg of compost per capita per year. Assuming the same level of activity and interest in Ontario, and a population of 9.6 million, the potential demand for compost in this province is 316,800 tonnes per year (with the equivalent amount of non-composted yard waste being 631,600 tonnes) (Note that 1 ton of compost requires 2 tons of yard waste.[42]

From Section 13.1, it is estimated that approximately 654,000 tonnes of yard waste were generated in 1989. Using the Minnesota study (i.e. 33 kg./capita/yr), it is estimated that potentially all yard waste in Ontario once composted can be absorbed.

A serious shortfall in market capacity emerges if food wastes are considered since roughly 625,000 tonnes are generated each year. An extensive network of farms utilizing food waste as animal feed is not necessarily the answer to this problem for a host of reasons[43]:

- there are some quality control issues associated with on-farm cooking of food waste
- hog farms that use food waste require a completely different facility and management system
- the equipment required to collect and process food waste is becoming more expensive
- the quality of source separated food waste (at restaurants, hotels etc.) is suspect
- hog farms cannot be located too close to urban areas for obvious reasons (odour being the primary one)

Greater potential exists perhaps in facilitating the collection and processing of food wastes through rendering businesses.[44] Rendered food wastes would then have to compete in the wholesale grain market with other animal feed products. For rendering to become more competitive with garbage haulers, one industry spokesman suggests higher tipping fees at the landfill and transfer stations and mandatory source separation of organics,[45] particularly from large volume generators.

The estimated supply of and demand for compost can be compared as shown in Table 13.9. These data include organics from both the residential and ICI sectors.

Quantities of organics diverted into backyard composters are not included as compost supply or demand since that material essentially never enters the waste stream. ICI food waste used as animal feed is also excluded from these figures.

Compost demand is based on the 33 kg./capita/year deduced from the Minnesota study above.

Table 13.9

Estimated Compost Supply and Demand for Ontario 1989, 1992 and 2000

Year (population)	Compost Supply	Compost Demand
1989 (9,598,600)	38,764 Tonnes	316,754 Tonnes
1992 (10,022,000)	222,646 Tonnes	330,726 Tonnes
2000 (10,896,000)	604,938 Tonnes	359,568 Tonnes

It should be noted that if a yard waste landfill disposal ban is introduced before the end of 1992, say at the end of 1991, then it is expected that compost supply in 1992 will be much greater than shown in Table 13.9.

Finally, the demand for compost as derived above is theoretical. Mature compost does not need a "market" to be of value since its disposition can occur wherever soil products are used. In other words, the demand for compost is extremely high if landspreading on agricultural lands or rejuvenation of derelict lands is considered.

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14.0 DISPOSABLE DIAPERS

14.1 Supply

14.1.1 Generation by Sector

Disposable diaper waste is the single largest "non-recyclable" (within existing recycling systems) consumer product component of Ontario's household garbage. It is estimated that every baby uses 8,000 to 10,000 diapers in their lifetime. If disposable diapers are used, this single product can represent 26.7% of the waste stream of a family of four with one child in diapers.[1] In 1989, 85% of Ontario babies were swaddled in disposable diapers, compared to 35% in 1976.[2]

Current Generation

According to CH_2M Hill diapers in the residential generation stream are estimated at 111,000 tonnes.

Pollution Probe estimates that the average Canadian hospital generates 35,900 kg of disposable diapers each year. There were 222 hospitals in Ontario in 1989.[3] Therefore Ontario hospitals generated about 8,000 tonnes of diapers in 1989. This ICI generation figure does not include generation by daycare or senior care facilities since reliable data are unavailable.

Projected Generation

The generation of disposable diaper waste in 1992 and 2000 is affected by the growth of Ontario's population. Since 1987, Canada has experienced a "mini baby boom" and it is unclear when this boom will subside.[4] Therefore, the calculation of generation assumes the growth in diaper generation is consistent with the projected Ontario population growth. The projected tonnage of disposable diapers in the future has been based on the projected population in 1992 and 2000. Therefore residential generation would be 115,900 tonnes in 1992 and 126,000 tonnes in 2000.

Disposable diaper waste generation for the ICI sector in 1992 and 2000 is similarly estimated at 8,400 tonnes and 9,100 tonnes.

The federal government's Environmental Choice Program as well as the general increase in environmental awareness and action in Ontario will undoubtedly result in a reduction in the use of disposable diapers. Pollution Probe estimates that the use of cloth diapers is increasing by 11% per year. This may result in an equivalent decrease in the use of disposable diapers but

this cannot be said for certain. Therefore, generation has not taken into consideration the increased use of cloth diapers.

14.1.2 Current and Projected Diversion Levels

Current Diversion

There were no programs diverting disposable diaper waste from landfills in 1989.

Projected Diversion

Residential diversion between 1989 and 1992 is affected by pilot recycling programs and lightweighting. Any decrease in the use of disposables as a result of a switch to cloth diapers will also influence the amount diverted, however, due to the uncertain quantity of this switch, the factor was not indicated in diversion.

Knowaste Technologies Inc. is expecting to pilot their disposable diaper recycling technology in 1991. Their planned facility is to process diaper waste from Toronto healthcare institutions. If the technology proves successful it will expand operations.[5] The Knowaste system has been piloted successfully in Europe. Markets for the materials generated are readily available, according to Knowaste. The plastic will be sold; fibre can be used in the manufacture of new diapers or in other fibre products; and, the absorbant gel material can be recovered for use in the clean up of chemical spills in industrial settings.

Diversion of disposable diapers will further be affected by the emergence of composting programs. Pilot programs for the composting of disposable diapers will occur with the financial and technological assistance of Canada's largest disposable diaper manufacturers, Procter and Gamble (P&G). P&G has already committed funds to composting efforts and are reformulating the outer liner of their diapers to make them more readily compostable.

Due to the uncertainty around the outcome of these pilot programs, RIS has not included diversion estimates through recycling as part of the total diversion estimates for 1992 and 2000.

A new Du Pont technology is presently being used in products for incontinence. It is expected to decrease diaper weight by 15% and be applied to baby diaper production by 1992.[6] This will divert 17,400 tonnes and 18,900 tonnes from the residential waste stream and 1,260 tonnes and 1,365 tonnes from the ICI sector in 1992 and 2000 respectively.

Table 14.1 summarizes generation and diversion estimates for disposable diapers in 1989, 1992 and 2000.

Table 14.1

Disposable Diapers - Generation and Diversion for Ontario

	1989 (tonnes)	1992 (tonnes)	2000 (tonnes)
Residential Generation	111,000	115,900	126,000
Diversion	0	17,400	18,900
ICI Generation	8,000	8,400	9,100
Diversion	0	1,260	1,365

14.1.3 Potential for Increased 3R's Activity

Reduction

Increased reduction of disposable diapers may occur with greater usage of cloth diapers and the use of diaper services. If the trend to use cloth diapers continues and perhaps even grows in the future the amount of disposable diaper waste will be reduced. Further lightweighting of disposable diapers also will reduce disposable diaper waste.

As well, bans on disposable diapers, being proposed in Barrie and Toronto will result in reduction in the use of disposables if implemented.

Reuse

Due to the nature of disposable diapers, reuse is not a feasible option.

Recycling

The possible expansion of the Knowaste recycling technology and the movement towards large scale composting programs are some of the possible future recycling initiatives.

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15.0 WOOD WASTE

15.1 Supply

Wood waste has been included in this study because it comprises a significant amount of the volume in landfill sites. There are many different types of wood wastes such as pallets, wood scraps, wood chips, shavings, sawdust, cable spools and landscaping and construction debris.

15.1.1 Generation by Sector

Current Generation

CH_2M Hill has estimated that in 1989, 46,700 tonnes of wood waste were generated from the residential sector. This represents a generation of 4.9 kg/capita/year of wood waste.

Wood waste from the ICI sector is generated from a number of different sources including:

- primary forest industries (lumber mills, pulp and paper mills);
- wood container industry (skids, pallets etc.);
- secondary wood industries (wood manufacturers);
- home construction and renovation;
- building demolition;
- municipalities (works and parks departments);
- conservation authorities and provincial and national parks; and
- commercial landscaping.

A recent study conducted for the Ontario Ministry of the Environment estimated wood waste generation from the ICI sector in the province for the study year of 1988 at 2,992,000 bone dry (BD) tonnes.[1] Table 15.1 provides a summary of wood waste generation and diversion tonnages by sector for 1988 and is discussed in the following sections. Historically, the industry recovers and reuses a substantial portion of wood by-products (1.6 million approximately) with the balance (1.4 million approximately) going to landfill. This latter figure has been used as the wood waste generation figure for 1989.

The discussion in this section about specific sources of wood waste is based on the 1988 generation numbers in the report referenced above.

Based on an 1988 Ontario population of 9,464,200 and a wood waste tonnage of 1,422,650, the per capita wood waste generation from the ICI sector is estimated at 150 kg/1988. The above referenced report indicates that wood waste generators do not anticipate significant changes in future wood waste generation.[2] Therefore, RIS has projected wood waste generation from the ICI sector for 1989 based on the 1988 per capita generation figure of 150 kg and the 1989 population of 9,598,000 or 1,439,700 tonnes.

Table 15.1

ESTIMATED WOOD WASTE MANAGEMENT PRACTICES IN ONTARIO BY SECTOR - 1988

SECTOR	ESTIMATED TOTAL WOOD WASTE GENERATION (Bone Dry Tonnes)	RECYCLED/REUSED/ RECOVERED (Bone Dry Tonnes)	DISPOSED OF (Bone Dry Tonnes)	DIVERSION FROM LANDFILL %
SOUTHERN ONTARIO				
Primary Forest Industry	461,400	277,000	184,400	60%
Secondary Wood Products and General Manufacturing	463,900	227,200	236,700	49%
Wood Container Industry	600,000	360,000	240,000	60%
Residential Construction	70,900	5,000	65,900	7%
Demolition	369,600	0	369,600	0%
Municipalities	158,800	31,800	127,000	20%
Conservation Authorities/ National and Provincial Parks	900	850	50	94%
Commercial Landscaping	22,000	10,000	12,000	45%
TOTAL SOUTHERN ONTARIO	*2,147,500*	*911,850*	*1,235,650*	*42%*
NORTHERN ONTARIO				
Primary Forest Industry	749,000	633,000	116,000	85%
Other	96,000	25,000	71,000	26%
TOTAL NORTHERN ONTARIO	*845,000*	*658,000*	*187,000*	*78%*
TOTAL - ONTARIO	**2,992,500**	**1,569,850**	**1,422,650**	**52%**

Source: Ministry of the Environment, Wood Waste Generation and Management in Ontario, April 1990, Tables 4-3.

Primary Forest Industries

The primary forest industry includes the pulp and paper manufacturing companies and lumber mills. The Ministry of Natural Resources maintains a data base on primary wood industry production and waste generation. In 1986, the most recent year for which detailed data are available, MNR estimated that 1,210,400 bone dry (BD) tonnes of wood waste were generated throughout Ontario.[3] Approximately 38% of this total was generated south of the French and Mattawa Rivers or 461,400 tonnes.

Secondary Wood Products and General Manufacturing

The secondary wood industry is comprised of those companies that primarily utilize oven (kiln) dried wood. These include manufacturers of furniture, doors, particle board and building materials.

General manufacturing companies include companies that do not utilize wood as a primary material in their production process, also generate wood waste from the packaging and transportation of the products. The types of wood waste generated by these companies include pallets, skids and crates.

The annual estimated wood waste generation for all secondary wood industry and general manufacturing companies in southern Ontario is estimated at 463,900 BD tonnes.[4]

Wood Container Industry

The Canadian Wood Pallet and Container Association has completed a survey which identifies that an estimated 600,000 BD tonnes of wood waste are generated by the wood container industry.[5]

Residential Construction

Wood waste generated in the residential construction industry is estimated at 70,900 BD tonnes.[6] Wood waste from this sector is comprised of damaged framing, lumber, off-cuts, particleboard and plywood.

Demolition

Wood waste generated through demolition activities in Southern Ontario is estimated to be 369,600 BD tonnes.[7] The wood waste generated reflects the wood used in the original construction of the structures that are demolished. The wood is generally high contaminated by other wastes.

Municipalities

The types of wood waste generated by municipalities include tree branches, damaged road signs and guard rails, pallets/skids and miscellaneous items such as Christmas trees. Wood waste generated by municipalities in southern Ontario is estimated to be 158,800 BD tonnes.[8]

Conservation Authorities, National and Provincial Parks

Wood waste is generated by maintenance activities by the conservation or park operators. Wood waste generated by Conservation Authorities and Parks in southern Ontario is estimated to be 900 BD tonnes.[9]

Commercial Landscaping

Brush and tree limbs and trimmings are the principal wood wastes generated by this sector. Wood waste generated by this sector in southern Ontario is estimated to be 22,000 BD tonnes.[10]

Northern Ontario

Estimates of wood waste generation in northern Ontario have been developed from existing 1986 MNR data and by extrapolating southern Ontario wood waste generation data. It is estimated that 62% of the total 1,210,400 BD tonnes generated throughout Ontario is from north of the French and Mattawa Rivers or 749,000 BD tonnes.

Wood waste generation in northern Ontario by sectors other than the primary forest products industry (see above) is estimated at 96,000 tonnes.[11]

Projected Generation

As indicated earlier, RIS has estimated generation based on 1989 per capita generation rates and increased population in 1992 and 2000.

For 1992 it is estimated that 49,100 tonnes of wood waste will be generated from the residential sector and 1,503,300 tonnes from the ICI sector. These projections are based on an Ontario population of 10,022,000 for 1992.

By 2000, it is estimated that 53,400 tonnes of wood waste will be generated from the residential sector and 1,634,400 tonnes from the ICI sector, based on an Ontario population of 10,896,000 for 2000.

15.1.2 Current and Projected Diversion Levels

Current Diversion

Wood waste has been utilized extensively across Ontario for many years. It is a credit to the industry that wood waste has been highly utilized especially in Northern Ontario. A 1989 summary of wood waste applications is provided in Table 15.2. This summary is based on 1988 diversion numbers in the MOE report. It is not known whether the diversion tonnages presented are actual capacities or are limited to the supply of processed wood waste available.

Table 15.2
Estimated Diversion of Wood Waste in Ontario - 1988

WOOD WASTE APPLICATIONS	ESTIMATED WOOD WASTE DIVERSION (Bone Dry Tonnes)
Pulp and Paper	10,000
Chip and Particle Board	200,000
Livestock Bedding	253,000
Compost/Mulch	25,000
Fire Logs	36,000
Recreational	25,000
Energy Recovery	958,000
Landscaping, Pet Litter	64,000
TOTAL DIVERSION	1,571,000*

* Numbers are rounded up and totals are slightly different than in Table 15.1.

Source: Ministry of the Environment, Wood Waste Generation and Management in Ontario, April 1991, Table 4-2.

Pulp and Paper

The pulp and paper industry utilizes wood chips in its production processes. The pulp and paper mills only accept clean, uncontaminated chips usually

from sawmills. In 1988, it was estimated that 10,000 tonnes of wood waste were reutilized by the pulp and paper industry.

Chip and Particle Board

Waste wood chips, sawdust and shavings are used extensively in the manufacture of chipboard, particleboard and other manufactured wood products. Current utilization of wood waste for this application is estimated at 200,000 tonnes.

The Domtar Particle Board facility in Huntsville is currently utilizing approximately 60,000 tonnes of the 200,000 tonnes of wood waste annually.[12] The supply of waste sawdust to this facility is mainly from secondary wood manufacturers within about a 100 km radius.

Domtar also operates a plant in Thorold which produces roofing felt. In this process, wood chips are mixed with waste paper and old corrugated cardboard. The wood fraction represents approximately 40% of the material. The plant uses 16,500 tonnes of wood chips annually from secondary sources in the Metro Toronto area.[13]

Bedding for Livestock

Some farmers utilize sawdust as bedding for livestock. The sawdust not only can serve its primary purpose, but it can subsequently be used on fields (mixed with manure) as a soil conditioner. The marketing of sawdust to farmers is conducted in an informal basis. The demand for livestock bedding is higher during the winter months when the animals are inside more often than during the summer months.

Wood waste utilized as animal bedding is estimated at 253,000 BD tonnes.

Composting

The composting of wood waste has been undertaken for several year in Ontario. Currently, there are several wood waste composting projects underway in the province including Philip Enterprises in Hamilton and Hillview Farms in Woodstock, both of which compost up to 10,000 tonnes each of wood waste annually, and White Rose Nurseries in Uxbridge, where 3,000 tonnes of wood waste are composted annually.[14]

Other wood waste composting programs include the composting of wood waste with sewage sludge by the Cities of Gloucester and Windsor, and the composting of paper mill sludge by Grow-Rich in the Region of Niagara.[15] No quantitative estimates were provided in report.

Wood waste composting in Ontario is estimated at 25,000 tonnes in 1988.

Energy Recovery

Energy recovery from wood wastes, both on-site and off-site, for Ontario in 1988 is estimated at 958,000 tonnes. It is estimated that 300,000 tonnes of wood waste were utilized in southern Ontario and the remaining 633,000 tonnes were utilized by northern Ontario pulp and paper industries and 25,000 tonnes by other northern Ontario industries.[16]

Specifically, the Ajax Energy Corporation in Ajax Ontario, has been burning wood waste to produce steam for a number of years. In 1989, this operation consumed approximately 25,000 tonnes of wood waste from the Greater Toronto Area (GTA).[17]

Fire Logs

Domestic fireplaces can be fuelled by burning fire logs produced from extruded wood waste chips and sawdust, rather than virgin wood.

Monto Industries of Toronto utilizes approximately 2,000 oven dry tonnes of wood waste annually.[18] Other fire log manufacturers include All-Wood Products and Kelly's Forest Fuel and Transfer Company.

Annual utilization of wood waste for the production of fire logs was estimated at 36,000 tonnes in 1988.

Recreational Applications

Waste wood chips and bark may be used on walking trails and gardens in parks by all levels of government. Wood waste is also used on ski slopes for erosion control and to mold the hill into the desired contours and moguls.

Annual utilization of wood waste for recreational applications was estimated at 25,000 tonnes in 1988.

Landscaping/Pet Litter

Landscaping businesses, homeowners, corporations and garden centres utilize waste chips and bark for landscaping and gardening uses.

Wood shavings are used by many pet owners for bedding. The tonnage diverted is minimal.

Annual utilization of wood waste for landscaping and pet litter applications was estimated at 64,000 tonnes in 1988.

Northern Ontario

In northern Ontario, MNR data indicate that 633,000 BD tonnes of the 749,000 BD tonnes of wood waste generated by the primary forest products industries were reutilized in 1986.[19]

Of the 96,000 BD tonnes of wood waste estimated to be generated in northern Ontario outside of the primary forest products industry, it is estimated that 25,000 BD tonnes are reused, most commonly for energy recovery.[20]

Projected 1992 Diversion

Wood waste diversion from the residential sector is included in the yard waste component of the organics discussion.

The MOE report indicates that markets for wood waste could be expanded. However, the report does not provide information on market capacity or projected diversions. Therefore, RIS has based wood waste diversion projections based on information related to planned expansions or new recycling facilities for wood waste, thereby diversion equals capacity.

The Region of Peel and the Ministry of the Environment assisted in the development of a wood processing center in Brampton, Ontario. The Waste Conversions Inc. (WCI) facility, which opened in November of 1989, reduces wood waste to wood chips and sawdust and markets the finished product. The supply of wood is guaranteed in Peel by the implementation of a wood waste disposal ban in December of 1989. Generators of wood are now required to separate wood waste and have it taken to the WCI facility. The tipping fee at WCI is $85/tonne which is $10/tonne less expensive than the local landfill. The capacity of the facility is approximately 30,000 tonnes per year.[21]

In April of 1991, Wood Waste Solutions applied to Metro Toronto Works Committee and the Ministry of the Environment to operate a wood pallet recovery and recycling facility to process approximately 18,000 tonnes annually.[22] They are expected to be operational in 1992.

Ajax Energy Corp. is increasing their capacity from 25,000 tonnes to 30,000 tonnes by 1992.[23]

The Domtar Particle Board facility in Huntsville facility is currently utilizing approximately 60,000 tonnes of wood waste annually. They are planning an

expansion which will double their consumption of wood waste to 120,000 tonnes by 1992.[24]

The Combiboard Ltd. plant in Bancroft is a new facility that opened in April of 1989. The plant utilizes 75,000 BD tonnes per year of chips and sawdust in the manufacture of products similar to particleboard.[25]

By 1992, the increase in wood waste processing capacity from these facilities is estimated to be 188,000 tonnes.

Projected 2000 Diversion

Wood waste diversion from the residential sector is included in the yard waste component of the organics discussion.

The Metro Toronto Works Committee has approved the construction of a wood distillation facility to be located at the Newnham Campus of Seneca College. The facility is proposed to accept approximately 40,000 tonnes of wood waste from the Metro Toronto area. The process essentially "cooks" the wood in the absence of oxygen to produce a combustible gas which can be fed to a boiler to produce steam for heat and electrical energy.[26] The facility will not be operational by 1992, therefore it is assumed the diversion tonnages will apply to 2000 projections.

There is a potential market for up to 100,000 tonnes per year of wood chips to be used as fuel for a new EFW plant being constructed in the Rochester, New York area.[27] RIS has indicated that this market would apply to 2000, however, it is potential only.

By 2000, the increase in wood waste processing capacity can conservatively be estimated at 140,000 tonnes. This estimate is low due to limited information available about future processing capacities which are in the planning stages.

Table 15.3

Wood Waste Generation and Diversion Estimates (tonnes/year)

	1989	1992	2000
Residential Generation	46,700	49,100	53,400
Residential Diversion	0	0	0
ICI Generation	1,439,700	1,503,300	1,634,400
ICI Diversion	0	188,000	328,000

15.1.3 Potential for Increased 3R's Activity

Reduction

Reduction in wood wood waste can be achieved through improved production technology, a change in product design or some other method. For example, saw blade and milling technology in sawmill industry can reduce wood waste.[28]

Reuse

The use of reusable pallets by the grocery products industry is an example of reuse[29] and could be adopted by other industry sectors by standardizing pallet designs.

In 1989, it is estimated that 12 million pallets were produced and used in Ontario. This represents an estimated weight of 272,000 tonnes of wood. Pallets can either be made of softwood or hardwood. Softwood pallets represent about 6.6 million or 105,000 tonnes of the total and tend to be used only once before discarded. It is estimated that only 1 in 30 softwood pallets are reused.[30]

There are two types of hardwood pallets: CPC hardwood and non-CPC hardwood. The CPC (Canadian Pallet Council) hardwood pallet is a standardized pallet that is used by over 750 association member companies across Canada and is estimated to represent over 37,000 tonnes of wood.[31]

The standardized CPC pallet is 48" X 40" and is designed and constructed to detail specifications in order to make it strong and cost efficient. Over 5 million of these standard pallets are circulating and being reused throughout the country, and over 2.5 million in Ontario at any given time. The CPC pallet has an economic life of approximately 110 trips, and licensed CPC members repair or chip broken pallets.[32]

The non-CPC hardwood pallet is used in a range of industries and while more durable than softwood pallets, they are not controlled and have an economic life of approximately 30 trips. These non-CPC pallets represent over 4.4 million pallets or approximately 130,000 tonnes.[33]

A greater shift by industry to reusable pallets, especially CPC pallets which are monitored and tracked, would reduce the amount of one-way soft wood pallets for disposal.

Recycling

Wood processing centres are operating in a number of locations in U.S. The facilities range from 14,000 to 47,000 tonnes per year (TPY) of throughput.

Most of these systems tend to combine industrial wood waste processing with yard waste processing systems for Christmas trees and other landscaping waste. The shredder or grinder technologies used, produce a wood shaving or chip, which can be further reduced to sawdust There is also the potential to operate mobile shredding or grinding units that could be shared between a number of municipalities to process collected wood waste.

Thus, it appears that reuse and recycling offer the greatest potential for wood waste diversion.

15.2 Demand

15.2.1 Market Structure

A number markets for wood waste were established prior to 1989. Northern Ontario has used wood waste as an industrial fuel source level for many years.

There is a wide range of uses for wood waste. Most uses require that the wood be reduced to either a wood chip, shaving or sawdust form. The end uses of wood waste include:

- hogfuel/fuel pellets/firewood;
- animal bedding;
- mulch/compost; and,
- secondary wood manufacturing.

The potential end uses for wood waste depend on the level of processing. Processing wood waste involves volume reduction for a specific market. Generally wood waste is found in the following forms:

- broken and whole pallets;
- crates and boxes;
- wood scraps and dimensional lumber;
- construction and demolition wood waste;
- wood chips and wood shavings;
- sawdust; and
- miscellaneous such as cable spools, telephone poles, railway ties, tree stumps and brush etc.

Bark waste generated from lumber mills and pulp and paper facilities is already used extensively as an energy source.

Manufactured woods such as particle board or laminated wood are sometimes considered contaminants for such applications as mulch, animal bedding and firewood because of possible hazards from chemical resins and binding agents. Wooden pallets that have absorbed spilled liquids such as oil also pose a possible contamination threat if used for animal bedding because this type chemical contamination can rarely be traced.

Markets for the various types of wood are discussed below.

Pallets

Pallets and skids are widely used in the packaging and transportation of industrial and consumer goods. The Canadian Wood Pallet and Container Association (CWPCA) has 52 Ontario pallet manufacturers as members. According to the CWPCA an estimated 3% of discarded pallets are recycled.[34]

The CWPCA estimates that over half of the pallets used in Ontario are used in the automotive and related industry, and another one-third of pallets are used in the grocery and consumer products industry.

There are five pallet repair companies in the GTA that are licensed by the CPC. There are another nine pallet refurbishers listed in the Metro Toronto Recycling Directory. A number of these companies have recently installed wood chipping equipment in order to chip broken pallets and wood scrap for sale and to reduce disposal costs.

Sawdust

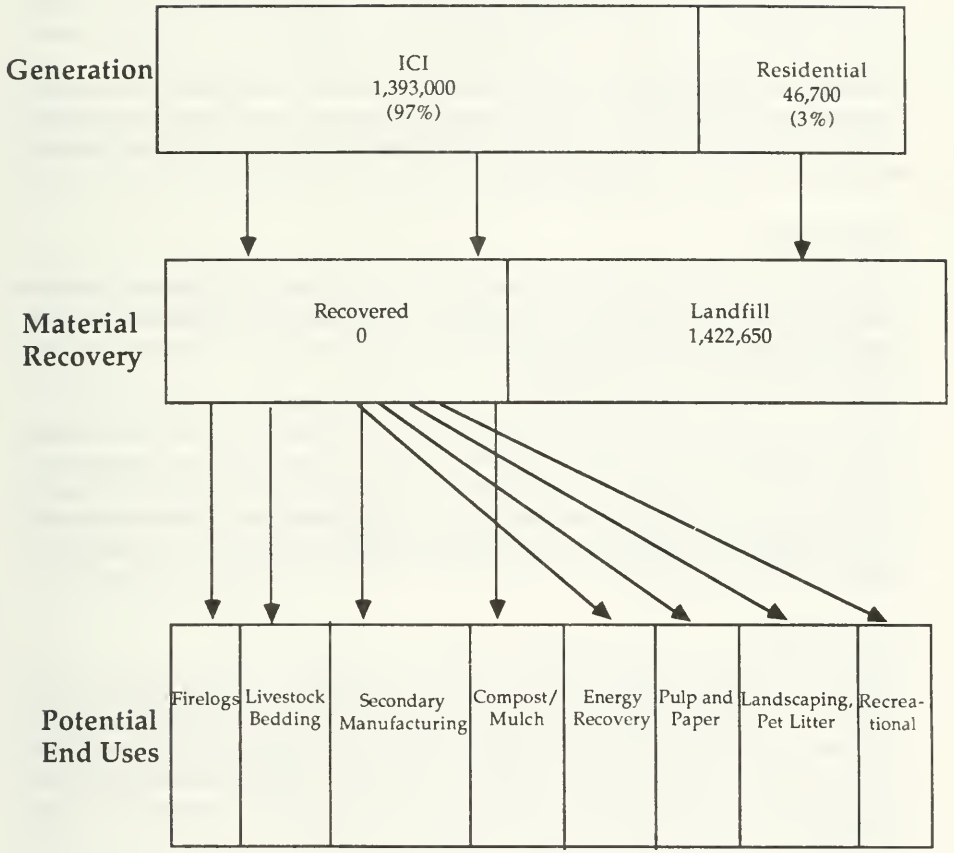
Sawdust can be used for a number of applications including as a fuel source, for animal bedding, and for other industrial uses. There are three companies listed in the Metro and Peel Markets Directory that deal with sawdust, plus a number of farms and livestock operations that are listed for sawdust.

Sawdust is used as a fuel source for a number of on-site and off-site energy recovery systems.

Sawdust also has the potential to be compressed into firelogs, primarily for home use. The greatest potential use of wood waste is as a fuel source for industry. The sawdust is pelletized and burned to produce steam for heating or for electricity. The attractiveness of wood depends upon the price of other fuels and the cost of the wood supply. Wood waste as a fuel source is used extensively across the U.S. and in most northern Canadian pulp and paper mills. The price paid for wood fuel in the U.S. ranges from $0 - $20/tonne.

Figure 15.1 provides a summary for Ontario markets for Wood.

Figure 15.1
Wood Waste (tonnes per year)
Ontario 1989



Sawdust is also used as animal bedding for cattle, horses and poultry. This market is seasonal, with the highest demand during the winter months. Animal bedding must be clean, metal free and contain no wood preservatives or other contaminants.

Domtar in Huntsville receives approximately 3,000 tonnes of wood waste from the GTA, mainly from the WCI facility in Brampton. This supply from GTA is expected to increase to approximately 30,000 tonnes by 1992. The average price paid by Domtar for the wood waste is $5/ton ($5.50/tonne) plus transportation costs.[35] At certain periods of time when area suppliers are having trouble unloading wood waste, Domtar is able to collect the material for no cost other than transportation.

Wood Scraps

Wood scraps are produced mainly from manufacturing operations and construction and demolition activities. Wood scraps by themselves are limited in their potential uses. Wood scraps are periodically given to employees and the public as firewood.

Wood scraps are also generated in large quantities from new home construction sites. A study for the Toronto Home Builders Association estimated that 44,500 tonnes of wood waste (dimensional and manufactured) is produced from construction sites in the GTA based on 35,000 new home starts annually.[36] If the wood scraps are in good condition, contractors may salvage and reuse them.

Wood Chips

The potential uses for wood chips include gardening and landscaping use. Some conservation authorities, parks departments and gardening nurseries use wood chips and shavings for mulch or as bulking agents in compost. Park and conservation authorities used wood chips for garden landscaping or for overlaying nature trails etc. Contamination is also a concern for these markets.

The Domtar plant in Thorold which produces roofing felt uses 16,500 tonnes of wood chips annually. Their suppliers are all based in the GTA and include Alcar Disposal, Eco-wood, Ontario Sawdust, WCI and Wood Waste Solutions. The price paid by Domtar for the wood chips ranges between $6-10/ton.[37]

Wood chips can also be used for fuel. The Ajax Energy Corp. operates a wood and gas fired generating facility which currently uses 25,000 tonnes of wood waste per year. They will soon be installing wood chipping equipment and a

magnetic separator in order to process the various types of wood waste received into a consistent sized chip.

15.2.2 Factors That Influence Demand

The factors that affect demand are dependent on the type and quality of wood waste and the end use to which it will be applied.

Alternative energy sources will continue to be in demand in Ontario. Determining factors include supply and the costs of traditional energy sources such as electricity and oil. Grants and subsidies are available from Ontario Hydro and the Ministry of Energy to industries that reduce or shift the demand load for electrical or fossil fuel energy sources.

Animal bedding is necessary for the care and treatment of commercial and recreational livestock. Other forms of animal bedding include straw, hay and in even shredded old newspaper. Factors that influence the type of bedding used are basically cost, availability and the quality of material in comparison to straw and hay. A shift in agriculture from field to cash crops could reduce straw and hay, thus stimulating demand for substitutes. This has already occurred in some parts of the U.S.

Mulch is used for a number of landscaping and agricultural uses. Conservation and park authorities use wood chips and shavings on paths and walking trails. Commercial landscapers and municipalities use wood chips and shavings for gardens and tree arrangements for private companies, parks and public flower beds.

Use of wood waste in secondary manufacturing operations such as particle board, wafer board or roofing products manufacturing requires an assured supply of clean forms of wood waste. Demand for finished manufactured building products depends on the economic state of the construction and renovation industry, which tend to be cyclical.

There are a number of barriers to increased usage of wood waste in Ontario. Technically, wood waste can only be utilized in a limited number of applications. Currently, these applications have either limited capacities for wood waste materials or inadequate local supplies and processing and contaminants present additional barriers.

Regionally, the largest quantities of wood waste are generated in northern or northwestern Ontario from lumber mills and pulp and paper facilities. Due to this local availability of wood waste, the majority of secondary wood manufacturers are located in northern Ontario. Wood waste is used extensively throughout northern Ontario as an energy source.

15.2.3 Factors That Influence Choice Between Primary and Secondary Material

Wood wastes in the form of chips, shavings, sawdust and off-cuts are limited in the number of applications available for reuse or recycling. Virgin wood products will always be required for lumber mills, furniture manufacturing and other high end uses.

Secondary wood waste does not usually compete with virgin wood for use in products. Wood waste as a byproduct of lumber mills, pulp and paper mills and manufacturing has historically been used for other purposes, namely as an energy source and animal bedding.

15.2.4 Price/Elasticity Analysis

The type of wood waste generated determines the competing primary wood product price. Sawdust, for example, can be used for animal bedding, as a fuel source, and in the manufacture of chip board.

Elasticities of demand and supply have not been estimated in the literature. It can be expected that these would vary by waste wood type and by final product. Current prices for wood waste are nominal to negative, indicating that demand is likely to be elastic, while supply may not.

15.3 Assessment of Market Capacity to Absorb Supply

One of the main constraining factors is the limited capabilities to process bulky wood waste into marketable forms such as wood chips or sawdust. Currently, wood waste generators have limited access to wood waste processing operations.

The ability of the market capacity to absorb supply depends upon the ability to process wood waste into wood chips or sawdust for which there is an end market demand. If the wood waste is in this form, the markets for wood waste will have the ability to absorb supply.

15.4 References

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34 Ontario Ministries of the Environment and Energy, Wood Waste Generation and Management in Ontario, April 1991, page 38.

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16.0 DRYWALL

16.1 Supply

Drywall is the principal interior wall covering now used throughout North America. Drywall, also known by its other names, gypsum board, gyproc or wallboard, is manufactured in large pieces usually $^1/_2$ to $^5/_8$ of an inch thick and is comprised of gypsum (based on calcium, a metallic element) that is covered on both sides by boxboard paper. Drywall is a component of the construction and demolition waste stream.

Drywall waste is found in two forms. One form consists of trimmings and off-cuts generated during the installation of drywall. In this form, the drywall is relatively clean and in whole pieces. The second form is found during tear-downs or the demolition of buildings. In this form, drywall is broken into pieces or even dust and tends to be mixed with insulation, wiring and other demolition waste. The drywall is most likely painted with lead paint and in some cases with older buildings, contaminated with asbestos. According to an industry representative, drywall recyclers do not accept for processing drywall from demolition activities, because of this contamination.[1] Diversion of this waste through market development will present some major challenges. Therefore, this market assessment focuses on drywall waste from new construction.

16.1.1 Generation

Current Generation

Residential Sector

CH_2M Hill estimates that 0.28 percent or 11,500 tonnes of the residential waste stream in 1989 is drywall waste.

ICI Sector-Housing Construction

Drywall waste in the ICI sector is directly related to housing starts as well as the building of new commercial and industrial facilities. In order to estimate the amount of drywall waste generated for the ICI sector, projections of building starts are necessary.

Actual numbers of housing starts were sourced from the Central Mortgage and Housing Corporation (CMHC) for the base years 1986-1990. CMHC projections for the years 1991 and 1992 were also available. Projections for the year 2000 were not available for the province of Ontario as forecasts are not

made so far into the future. The Conference Board does ten year housing projections however, projections are only available for Canada as a whole.[2]

According to CMHC, there were approximately 93,337 houses constructed in Ontario in 1989. New Westminster Gypsum estimates that approximately 1 pound of drywall waste is generated for each square foot of finished floor space in a house.[3] This results in a waste of 1135 kg of drywall per house based on an average of 2500 square feet of finished floor space per house. Although these figures may vary depending on the size and style of house, they are considered to be a reliable average.[4] It is also the opinion of New West Gypsum that the figure of one pound of waste per square foot of finished floor space will remain constant in the future as it is based on standard construction practices.[5] Therefore, using the method described above, approximately 105,900 tonnes of drywall waste were generated in 1989 in the housing industry alone.

In order to identify the amount of drywall waste in the GTA as a percentage of all of Ontario, separate housing starts and resulting drywall waste figures were identified for the GTA. For the GTA alone, housing starts in 1989 were approximately 38,700.[6] Using the formula described above, the drywall waste generated as a result of the construction of new homes in the GTA in 1989 is 43,900 tonnes. This represents approximately 40% of the total drywall waste generated as a result of housing construction in Ontario in 1989. Information on industrial and commercial starts was only available for the GTA so calculations for all of Ontario were based on this percentage.

ICI Sector-Industrial Construction

Industry representatives were unable to provide a specific figure on how much drywall would be wasted during the construction of industrial or commercial facilities. However, they did indicate that it would be less than that for housing because of standard sized walls etc. found in most commercial and industrial buildings.[7] Due to the lack of an industry estimate for drywall wastage and in order to calculate the amount of drywall wastage during the construction of industrial and commercial buildings, RIS has assumed that .5 pounds of drywall would be wasted per square foot of finished floor space.

Industrial starts for the Greater Toronto Area only were available for 1989 and 1990 from the Toronto Real Estate Board. In 1989, 30,825,000 square feet of new industrial space was constructed. Therefore, using the figure of .5 pounds of drywall waste per square foot of finished floor space, approximately 7,000 tonnes of drywall waste were generated in the Greater Toronto area from the construction of industrial facilities in 1989.

To estimate generation of drywall waste in all of Ontario is was assumed that the GTA represents approximately 40% of the growth in the province based on population information from Statistics Canada and new housing construction information from CMHC. It is estimated that in 1989, 77,062,500 square feet of new industrial space was constructed in all of Ontario. Approximately 17,500 tonnes of drywall waste was generated in the province of Ontario as a result of this industrial construction.

ICI-Sector-Commercial Construction

Commercial starts were available for 1983-1995 from Royal LePage for the GTA. In 1989, 10,913,000 square feet of new commercial space was constructed in the GTA. Assuming again that the GTA represents approximately 40% of the province, 27,282,500 square feet of new commercial space was constructed in all of Ontario in 1989. Using the figure of .5 pounds of waste per square foot of finished floor space, the drywall waste generation for commercial construction is 2,500 tonnes in the GTA and 6,200 tonnes in all of Ontario for 1989.

Projected Generation

Residential Sector

Due to the unavailability of aggregated information on building permits issued in Ontario, future generation of drywall waste from the residential sector was based on per capita 1989 drywall waste generation, and increased according to the projected population in 1992 and 2000. The 1989 CH_2M Hill estimate of drywall generation from the residential sector was used as a base to project the generation amount in 1992 and 2000. On this basis, it is estimated that 12,000 tonnes of drywall waste will be generated in the residential sector in 1992 and 13,100 tonnes in the year 2000.

ICI Sector-Housing Construction

CMHC has forecasted 70,000 housing starts for 1992. This number of housing starts is slightly higher than the actual 62,600 starts for 1990. Thus, the generation of drywall waste in the housing portion of the ICI sector for 1992 will be approximately 79,500 tonnes based on the same method as described above.

The economy, population increases and immigration are factors that effect the forecasting of housing starts. CMHC representatives indicated that the state of the economy and the amount of immigration are unknowns for the year 2000; however, it is expected that future demand will not result in the housing construction boom experienced in the late 1980's.[8] If there is no

significant increase in the population as a result of immigration, the number of housing starts in the province is expected to remain at about 63,200 annually based on the average number of yearly housing starts for the years 1990 to 1992. Therefore, the generation of drywall waste from housing starts for the year 2000 would be approximately 71,700 tonnes.

For the GTA, the housing start forecast for 1992 was approximately 26,200.[9] Based on the average numbers of actual and projected houses constructed in 1990-1992, the projection for housing starts in the year 2000 is about 22,000. Using the format described above, the drywall waste generated estimated as a result of the construction of new homes in the GTA in 1992 and 2000 is 29,700 tonnes and 25,000 tonnes respectively.

ICI Sector-Industrial Construction

Unfortunately, industry representatives were unable to predict the amount of industrial space that will be constructed in 1992 and 2000.[10] However, according to the Toronto Real Estate Board the number of industrial construction starts in the GTA in 1990 was 14,204,000 square feet or almost half that of 1989.[11] Other projections in this section were based on information from the 1990's rather that the boom years of the late 1980's. Therefore, RIS decided to use this 1990 generation figure to represent new square footage in 1992 and 2000. Generation of drywall waste in the industrial portion of the ICI sector in both 1992 and 2000 is estimated to be 3200 tonnes in the GTA.

ICI Sector-Commercial Construction

The Royal LePage projection for 1992 indicated 5,195,000 new square feet of commercial space would be constructed in the GTA. Using .5 pounds of drywall waste/square foot of finished floor space, this calculates into a projected drywall waste as a result of commercial construction of approximately 1,200 tonnes for the GTA. Commercial construction in all of Ontario is estimated at 12,987,500 square feet in 1992. Therefore, commercial construction drywall waste for all of Ontario in 1992 would be approximately 3,000 tonnes.

Royal LePage was unable to provide predictions for the year 2000. Therefore, RIS has calculated the number of new square feet of commercial space to be constructed in 2000 based on the average number of square feet predicted to be constructed from 1991 to 1995 in the GTA. The commercial start projection in the GTA for the year 2000 is 8,276,000 square feet. Therefore, projected drywall waste from commercial construction in the GTA for the year 2000 is 1,900 tonnes. Estimating that 20,700,000 square feet of new commercial space will be constructed in all of Ontario in 2000, approximately 4,700 tonnes of drywall waste will be generated for the whole province.

In summary, the total drywall waste generated in the residential sector in 1989 and predicted for 1992 and 2000 in Ontario is as follows: 11,500 tonnes in 1989, 12,000 tonnes in 1992 and 13,100 tonnes in 2000. The total drywall waste generated in the ICI sectors in 1989 and predicted for 1992 and 2000 in Ontario is as follows: 129,600 tonnes in 1989, 90,500 tonnes in 1992 and 84,400 tonnes in 2000. **These are conservative estimates because drywall waste from renovation in the ICI sector is not included.**

16.1.2 Current and Projected Diversion Levels

Current Diversion

Due to low average volumes and the high potential of contamination with demolition related waste, RIS has assumed that curbside recovery of drywall waste from the residential sector is not yet feasible. Individual homeowners however, may take their used drywall to one of the transfer stations or processing plants, or municipalities could initiate special pickups where volumes warrant..

Only one recycling operation, Canagro, located in Elmira, was operating in 1989 and it recycled approximately 1,000 tonnes of drywall material in that year.[12]

Projected Diversion

Disposal bans on the landfilling of recyclable drywall were initiated in Peel and Metro Toronto on May 1, 1990. Since York and Durham landfill their waste in Metro, they must also comply with this drywall ban. As of Spring 1991, drywall bans are also in effect in Hamilton-Wentworth, Halton, North Simcoe and Sarnia.[13] RIS has been unable to obtain any specific information as to which municipalities will ban drywall waste or other construction materials in the future. Therefore, it has been assumed that the implementation of disposal bans is a trend which can be expected to continue in a number of areas in Southern Ontario such as Waterloo, Guelph, Haldimand-Norfolk, Niagara and the counties of Essex, Brant, Lambton, Kent, Middlesex, Dufferin, Oxford and Simcoe, due to their proximity to drywall recyclers and landfill pressures in these areas. Increased tipping fees may also increase diversion of drywall.

New West Gypsum, located in Oakville, began processing drywall waste on May 1, 1990. They processed approximately 7,500 tonnes of drywall waste during the first year of operation which was sold to Westroc Industries for recycling into new drywall.[14] New West expects their processing rate to double in their second year of operation.[15] Canadian Gypsum Corp. (CGC), a

manufacturer of drywall in Hagersville, started a drywall waste processing operation in 1990. CGC indicated that they processed and recycled approximately 5,000 tonnes of drywall waste during the first year of the bans.[16] Domtar, another drywall manufacturer in Caledonia, also processes and recycles drywall waste. Domtar was unable to provide specific figures on the amount of drywall waste recycled in 1990. Since the other two companies processed similar amounts of drywall waste, RIS assumed that Domtar would not differ significantly. Therefore, it is estimated that they processed and recycled approximately 5,000 tonnes in 1990.

It should be noted that approximately 93-100% of the drywall waste received by the drywall recyclers is actually recycled. The centre portion of the board is recycled back into gypsum to be used in new drywall. New West Gypsum also sends the paper portion of the board out to be recycled.[17] This paper represents approximately 7% of the drywall.[18]

In order to calculate diversion of drywall waste into the future, 1990 diversion levels were used as a base. The three main drywall processors who were operating in 1990 are located in the Golden Horseshoe and serve mainly the GTA. Therefore, in order to calculate the diversion, drywall waste generation information from the GTA only was used. The housing, industrial and commercial starts in the GTA for 1990 were received from CMHC, the Toronto Real Estate Board and Royal LePage respectively. They are as follows: 20,912 houses, 14,204,000 square feet of industrial space, and 9,784,000 square feet of commercial space. The total drywall waste from these ICI sources in 1990 is 29,200 tonnes. In 1990, the three main drywall recyclers recycled approximately 17,500 tonnes of drywall. This is approximately 60% of the total drywall waste generated in the GTA that year. This represents the diversion during the first year of the bans when processors were not operating all year and the full effect of the bans may not have been felt.

To estimate the amount of drywall waste diverted and recycled in 1992, RIS has assumed that the bans existing in 1990 will be fully enforced. Allowing for some leeway this is expected to result in a diversion of about 90% of the drywall waste generated in the GTA. In 1992 the estimate for drywall waste generation in the GTA for the ICI sector is 34,100 tonnes. Therefore, the diversion estimated for 1992 in the GTA is 90% of that or, 30,700 tonnes.

To estimate the amount of drywall waste diverted and recycled in 2000, RIS has assumed that landfill bans will also be in place and enforced in the other regions mentioned above and that approximately 90% of the waste drywall generated is diverted. Since most of these bans are outside of the GTA it would not be accurate to use waste generated in the GTA only to calculate projected diversion. Using the projected demographics for Ontario in the year 2000, found in the appendix if this report, it was determined that the number of households in the areas with anticipated landfill bans represents

approximately 70% of the province. Therefore, 70% of the ICI generation for all of Ontario in the year 2000 was used to calculate the 2000 diversion. It is estimated that 53,200 tonnes of drywall waste will be diverted in 2000.

Table 16.1

Drywall Waste Generation and Diversion Estimates (tonnes/year)

	1989	1992	2000
Residential Generation	11,500	12,000	13,100
Residential Diversion	0	0	0
ICI Generation	129,600	90,500	84,400
ICI Diversion	1,000	34,100	53,200

16.1.3 Potential for Increased 3Rs Activity

Reduction

Reduction in drywall waste could potentially occur as a result of the type of drywall used (i.e. use of thinner drywall) and the installation process (i.e. less wasteful construction practices). Drywall is usually manufactured in $^1/_2$ to $^5/_8$ inch board. An industry representative was asked whether drywall use and waste could be reduced by the manufacturing of thinner board. It was indicated that thinner board would require that wall studs be placed closer together than the present standard practice. Therefore, it was considered not possible to manufacture a thinner drywall and still maintain quality standards.[19] As previously mentioned, industry representatives indicated that drywall wastage during construction is as a result of normal construction practices which are not expected to change significantly over time. Therefore, there is not much room for reduction in the use/waste of drywall.

Reuse

Drywall waste is in the form of small bent or broken pieces. There is not much potential for the reuse of this material in the construction or other industries.

Recycling

Recycling is the most feasible option for drywall waste. As the trend to ban drywall waste from landfills continues, the amount of drywall diverted from

local landfills will increase, thus increasing the amount available for recycling. The first bans on drywall were instituted in the GTA in May of 1990. Recycling of drywall waste in 1990 was about 60% of what was generated in the GTA. It is expected that the amount of drywall waste recycled in the GTA in 1991 will be substantially higher.

The development of a central facility that will accept for processing mixed construction and demolition wastes could have a negative effect on the amount of drywall available for recycling. Drywall that is part of a mixed waste stream would be difficult to recover due to the fact that gypsum is easily crushed. Once crushed the small pieces of gypsum and the gypsum dust is almost impossible to separate from other construction waste materials. Therefore, in order to ensure that the drywall waste is in suitable condition for processing it would be necessary to source separate it at the construction site.

16.2 Demand

16.2.1 Market Structure

There are three main processors for source separated drywall waste in Ontario; Canadian Gypsum Corp. (CGC), Domtar Gypsum, and Westroc Industries. The first two firms are drywall manufacturers that have on-site processing facilities for post-consumer drywall. The third is a drywall manufacturer that buys used drywall for recycling into new drywall from the drywall waste processor New West Gypsum located in Oakville. Together they have capacity to process 85,000 tonnes per year.

Once construction began on the New West Gypsum processing facility and agreements for the purchase of the recycled gypsum were signed with Westroc, the two other drywall manufacturers decided to provide recycling services. Agreements between the drywall manufacturers, Domtar and CGC and the waste haulers, Waste Management Inc. (WMI) and Laidlaw respectively were settled just before the implementation of the disposal bans. All three processing facilities began operation in early 1990.

Both Laidlaw Waste Systems and WMI have set up depots for clean drywall waste throughout GTA and are charging fees of $65-$75 to drop-off drywall waste. These haulers then transport the collected drywall to the respective manufacturers for processing and recycling. Both manufacturers use their own equipment to process the material for use as new drywall.

There are a large number of companies which provide the service of sorting out post-consumer drywall from other construction waste to supply a clean

stream to the drywall recyclers.[20] Currently, there are 17 locations within the GTA to which drywall can be taken. Another eight drywall depot locations are located in Hamilton-Wentworth, Waterloo Region, Brantford and Barrie. These include the locations run by Laidlaw and WMI as well as other companies and in some cases local landfill transfer stations.

Once the drywall is collected and transported to the processing facilities, the material is sorted to remove any contamination. Once the clean recyclable drywall has been segregated, the system for processing involves breaking up the drywall board to separate the gypsum from the paper coverings. The gypsum is then blended into the manufacture of new drywall, and the waste paper is disposed, or in the case of New West Gypsum sent out for recycling. The waste paper is being tested for use as animal bedding.

The estimated annual capacities of post-consumer drywall for the three facilities are:

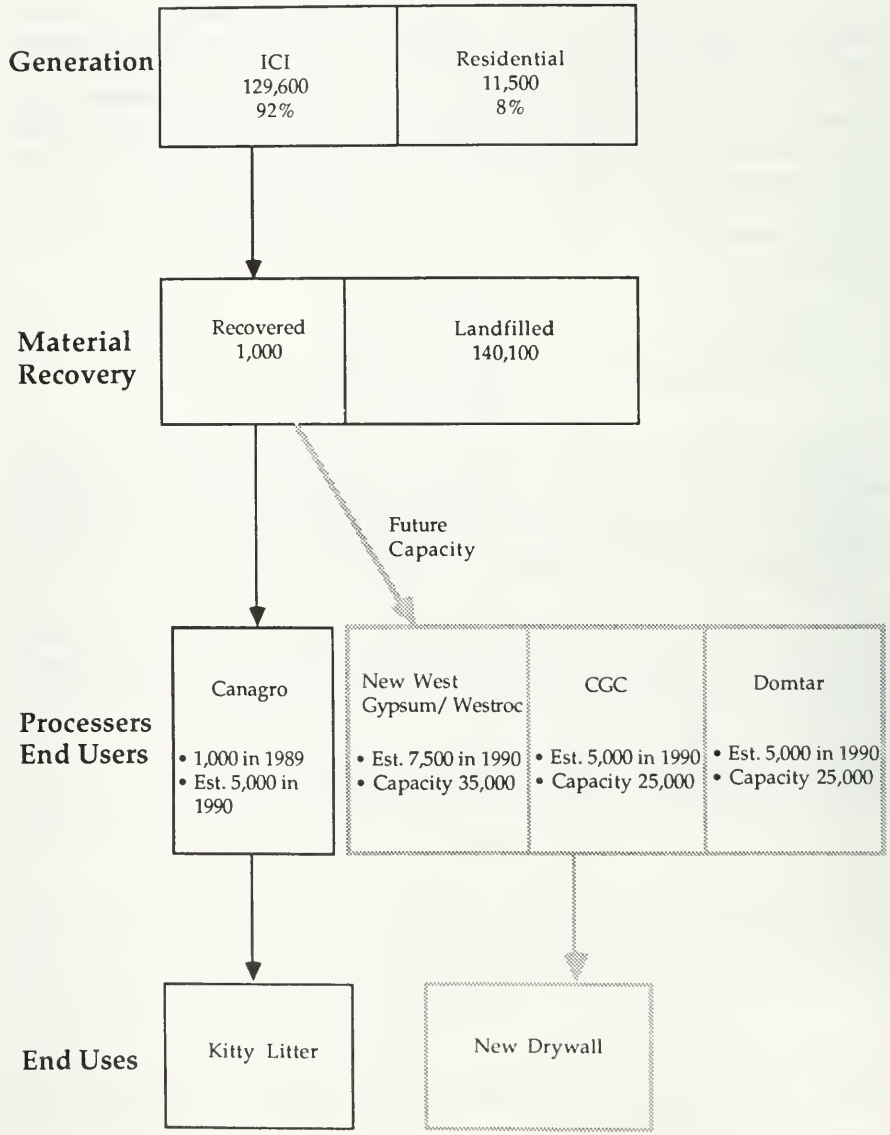
CGC	25,000 tonnes/year
Domtar	25,000 tonnes/year
New West Gypsum	35,000 tonnes/year
	85,000 tonnes/year

A fourth market for drywall waste is Canagro which uses the gypsum recovered to produce kitty litter and organic fertilizers. Canagro was the only operating drywall recycler in 1989 utilizing an estimated 1,000 tonnes of material. Its estimated capacity in 1990 will be 5,000 tonnes/year and the company anticipates a 1992 capacity of 10,000 tonnes/year.[21]

Canagro is not currently charging a tipping fee due to the low contamination of material received from a few contracted site cleaners. As capacity increases, a tipping fee will likely be required as contamination becomes more of a problem.

Figure 16.1 provides a summary for Ontario markets for Drywall.

FIGURE 16.1
Drywall (tonnes per year)
Ontario 1989



16.2.2 Factors That Influence Demand

The primary factor that influences the demand for post-consumer drywall is the demand for new drywall. The demand for new drywall relates to the amount of activity in the construction industry. In the 'boom' construction periods such as 1987 and 1988, demand for new drywall was very high. Since 1990, Ontario construction starts declined significantly.[22]

A second factor is a secure and consistent supply of waste drywall. High landfill tipping fees and/or bans can impact the diversion of landfilled drywall waste to recycling facilities. Currently, tipping fees at depot locations collecting drywall range between $65-75/tonne depending on distance from the processing facility and the quality of the drywall. Therefore, landfill tipping fees of $70/tonne or more are necessary in order to provide financial incentive for haulers to take drywall to collection stations, unless drywall is banned. Within the GTA, tipping fees are $85/tonne and higher. Outside the GTA tipping fees are rarely higher that $70/tonne. This limits the amount of drywall waste available for recycling into new drywall.

16.2.3 Factors That Influence the Choice Between Secondary and Primary Material

Gypsum is the primary material found in drywall. Virgin gypsum is a widespread commodity available at a relatively low cost.[23] Gypsum is not usually purchased on the open market as most of the drywall manufacturers either have their own supply or are connected with a company who supplies several manufacturers.[24] Gypsum is also generated as a by-product of industrial off-gas scrubbing systems particularly in coal fired generators in the U.S. and this too adds to total potential supply for reprocessing. The cost of virgin gypsum has been reported to be $10.50-$11.00 per ton.[25] CGC also indicated that it is considered more expensive to produce drywall using post consumer gypsum.[26]

Increased bans on the disposal of drywall is a factor that will influence the amount of drywall waste available for recycling. Thus, increasing the availability of secondary gypsum for use in drywall manufacturing. This would increase the likelihood of a constant supply for the manufacturing industry.

The quantity of post-consumer drywall used in new drywall production depends on the individual mills using the recycled gypsum and their processing systems and equipment. The recycled gypsum has small pieces of paper mixed in with the gypsum. When recycled gypsum is mixed with

virgin gypsum and ground to fine particles this paper does not break up into smaller pieces. Since the paper is a different density than the mineral, it has a tendency to mix unevenly within the mineral. This results in difficulties creating the proper mixture to make the drywall. It is possible to alleviate most if not all of these problems; however, drywall recycling is relatively new and this has not been accomplished yet.[27] In Ontario the use of post-consumer gypsum in new drywall manufacturing is currently at between 5% and 13% depending on the manufacturer.[28] In Vancouver, where New Westminster Gypsum operates, the use of post-consumer drywall in new drywall manufacturing is about 17% and is expected in increase to about 20% in the near future.[29]

16.2.4 Price/Elasticity Analysis

No data were found describing the price elasticities of demand and supply for waste drywall. The only firm engaged in drywall recycling in Ontario in 1989 charged no tipping fee, but offered no payment in return for the 1,000 tonnes it accepted that year. In 1990 three drywall-to-drywall recyclers commenced operations. The quantity they are cumulatively able to consume is about 85,000 tonnes.

16.3 Assessment of Market Capacity to Absorb Supply

The estimated generation of drywall waste in Ontario in the ICI sectors in 1992 and 2000 is 90,500 tonnes and 84,400 tonnes respectively. This is a conservative estimate as it does not take into consideration drywall waste from the renovation of ICI sector buildings. The total 1990 estimated capacity for recycling drywall is as stated above, about 85,000 tonnes. Therefore, there is processing capacity to handle most drywall waste generated.

At present in Ontario, about 5-13% post consumer drywall waste can be used in the manufacturing of new drywall depending on the individual manufacturers. Thus the demand for processed drywall waste is between 5-13%. This percentage could increase to approximately 20% in the future as is the case in Vancouver, British Columbia. Industry representatives estimate that approximately 800,000 tonnes of drywall was sold in Ontario during 1989. They also estimated that the percentage of waste drywall in 1989 was 10-15% of sales.[30] Therefore, the amount of drywall waste generated coincides closely with the demand.

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17.0 SCRAP TIRES

17.1 Supply

The tire fire in Hagersville Ontario brought attention to the potential hazards associated with storing tires in large, unmanaged tire piles. In April, 1990 as a result of the fire, Regulation 309 under the Environmental Protection Act was revised to give the Ontario Ministry of the Environment (MOE) additional authority to regulate tire piles and scrap tire processing facilities. Tires are now classified as "designated wastes" and used tires storage sites are now classified as "waste disposal sites". As a result of these changes, effective October 1, 1990, all sites on which there are 5,000 or more used tires will require a Certificate of Approval from the MOE in order to operate.

17.1.1 Generation By Sector

Current Generation

Ontario currently generates approximately 7 million tires per year from all sources (tire manufacturers, used tire sales, retread tires sales, autos scrapped and auto accidents) and include passenger, truck, trailer, bus, tractor, and aircraft tires. The weight of these tires varies depending on their use. These various tire uses can be translated into a consistent passenger-tire equivalent figure of 9.89 million tires 1989.[1] This does not include the estimated 2.8 million passenger-tire equivalent tires that are resold or retreaded.

With each passenger tire weighing approximately 9 kilograms, this translates to a passenger tire equivalent of approximately 89,000 tonnes of used tires in 1989. This includes all tires that were landfilled, added to tire stockpiles, recycled and exported for recycling.

CH_2M Hill estimates that approximately 800 tonnes of tires are generated from the residential sector in 1989. The remaining 88,200 tonnes were generated from the ICI sector, mainly from tire dealers and truck servicing operations.

Projected Generation

A 1986 report inventory study conducted for the Ontario Ministries of the Environment and Energy estimated scrap tire generation in the province at 9.3 kg/capita/year.[2] This estimate is based on 1985 tire generation at 78,170 tonnes and Ontario population of 8,409,752.

The 1989 per capita scrap tire generation is also estimated at 9.3 kg, based on scrap tire generation of 89,000 tonnes and a provincial population of 9,598,600.

Therefore, assuming scrap tire per capita generation of 9.3 kg continues in the future, by 1992 based on a population of 10,002,000, approximately 840 tonnes and 92,360 tonnes of tires will be generated from the residential and ICI sector respectively. By 2000, the estimates for tire generation from the residential sector at 900 tonnes and 100,500 tonnes from the ICI sector based on a 2000 population of 10,896,000.

17.1.2 Current and Projected Diversion Levels

Current Diversion

In 1989, it is estimated that 89,000 tonnes of new scrap tires were generated in Ontario. The disposal of this material was estimated to be as follows:[3]

- 67,700 tonnes landfilled
- 11,300 tonnes added to tire piles
- 6,100 tonnes were recycled
- 2,300 tonnes exported to Mexico or the Caribbean
- 1,500 tonnes other use (eg dock construction)

The Ontario tire recycling market consists of a small number of industries. Approximately 3,250 tonnes of scarp tire was consumed by Resource Recovery in Orangeville, as part of their crumb rubber processing operation. Sportbau Canada used about 150 tonnes in the manufacture of athletic track facilities. The remaining 2,700 tonnes were used in the production of blasting mats.

Projected Diversion

In August 1990, the MOE has just awarded over $19 million in grants to Recovery Technologies, National Rubber, Sportbau Canada and Viceroy-Trent Group to increase the production of crumb rubber in the province. The total impact of these recycling technologies is expected to increase from 6,100 tonnes in 1989 to 31,300 tonnes in 1992 as listed below:

Table 17.1

Projected Crumb Rubber Processors Recycling Capacity in Ontario 1992

Resource Recovery, Orangeville	4,000 tonnes[4]
Ontario Tire Recycling, Port Colborne	10,500 tonnes[5]
Recovery Technologies Inc., Ayr	500 tonnes[6]
National Rubber, Toronto	9,000 tonnes[7]
Sportbau Canada, Mississauga	300 tonnes[8]
Viceroy-Trent Group, Lindsay	7,000 tonnes[9]
Total Increased Capacities	**31,300 tonnes**

Whole tire applications such as retreading is expected to play a major factor in future tire diversion programs. Passenger tire retreading has been on the decline for the last 15 years. This is mainly due to the increased use of all-season radial tires which have replaced retreaded snow tires and the availability of new tires at costs comparable to retreaded tires. In contrast, retreaded truck tire sales have increased due to the larger price differential between new and retreaded truck tires.[10]

By 2000, the MOE-funded crumb rubber processing facilities will be operating at maximum capacity. This means an increase of capacity from 31,300 tonnes in 1992 to 180,500 tonnes by 2000. The maximum capacities of the six known crumb rubber processors is listed below:

Table 17.2

Projected Crumb Rubber Processors Recycling Capacity in Ontario 2000

Resource Recovery, Orangeville	9,000 tonnes
Ontario Tire Recycling, Port Colborne	10,500 tonnes
Recovery Technologies Inc., Ayr	7,500 tonnes
National Rubber, Toronto	72,000 tonnes
Sportbau Canada, Mississauga	500 tonnes
Viceroy-Trent Group, Lindsay	81,000 tonnes
Total Increased Capacities	**180,500 tonnes**

The diversion rate of scrap tires is a concept which refers to the reduction of tires sent to landfill or to tire piles, as measured by weight In order to estimate the diversion rate for 1992 and 2000, two sets of information are

required: total weight of tire material generated and total amount of material sent to each end-source (eg landfilling or recycling)

Generation estimates of scrap tires in 1992 and 2000 are derived from a 1989 per capita generation rate . Data in this report suggest that 93,200 tonnes of scrap tires will be generated in 1992 and 101,400 tonnes in 2000.

Estimating the overall diversion rate of scrap tires is a precarious task because of the difficulties in obtaining reasonably accurate projections about the amount of material consumed by each end-source. It is, for example, difficult to estimate the number of tires which may be exported in 1992. The lack of data is characteristic of most categories of tire end-uses.

The one area for which projections do exist for end-use consumption is recycling. MOE announcements in August of 1990 suggests that the technical capacity to recycle scrap tires in Ontario will jump to 31,300 tonnes in 1992 from the 1989 level of 6,100 tonnes. By 2000, capacity is expected to increase to 180,500 tonnes. Assuming that technical capacity to recycle is a direct reflection of the relative demand for scrap tire material, then these estimates can be taken as rough approximations of the level of scrap tire consumption for 1992 and 2000.

Although it is estimated that 31,300 tonnes of scrap tire will be recycled in 1992, the consumption of this material does not represent an accurate diversion estimate of newly generated tires. Some of this demand will be fed from newly generated scrap tires and some will be drawn from existing tire piles. Similarly, not all newly generated tires will be destined for recycling and it seems likely that a portion of this new material will be recycled and a portion will be be treated in other ways, such as exporting or tire piling. The question is, then, what portion of newly generated tires in 1992 and 2000 will likely be recycled and what portion of the new scrap material will be treated in other ways. The answer to this question is based on several assumptions and is calculated in the following manner:

- The total available supply of scrap tires for recycling in 1992 is the sum of the all newly generated scrap tires for that year plus the total tire pile supply for that year.

  As noted above, it is estimated that 93,200 tonnes of new scrap tires will be generated in 1992.

  The projected tire pile supply is estimated as follows: the tire pile in 1989 was estimated to be 80,700 tonnes. Between 1988 and 1989 the provincial tire pile supply grew by 11,300 tonnes. Subsequent growth in the tire pile is assumed to increase by the same figure.

Therefore, by the end of 1991, 103,300 tonnes of tires will exist in piles.

- Combining the total 1991 tire pile supply with the 1992 generation estimate means that the total 1992 tire supply is expected to be 196,500 tonnes (93,200 + 103,300).

- Expressed as a percentage, the new generation of scrap tires in 1992 represents about 47% of the total available tire supply (93,300/196,500).

Assuming that the source of tires consumed at a recycling plant is roughly equal to the proportional relationship between newly generated tires and the entire tire supply, then it is estimated that 14,700 tonnes of new tires will be diverted from landfills in 1992 (31,300 tonnes recycling capacity x 47%).

The amount of newly generated tires destined for recycling in 2000 is calculated in the same way:

- The generation of new scrap tires is estimated to be 101,400 tonnes.

- Total available tire stock is estimated to be 295,400 tonnes (101,400 + 194,000 tonnes in the stockpile).

- New generation constitutes about 34% of the entire available supply (101,400/295,400).

Assuming that the source of tires consumed at recycling facilities roughly corresponds to this proportion, then the amount of new scrap tires to be diverted from landfill or tire piles in 2000 is expected to be approximately 64,700 tonnes. (190,400 x 34%).

Table 17.3 summaries tire generation and diversion estimates.

Table 17.3

Tire Generation and Diversion Estimates (tonnes/year)

	1989	1992	2000
Residential Generation	800	840	900
Residential Diversion	0	0	0
ICI Generation	88,200	93,200	100,500
ICI Diversion	6,100	14,700	61,400

17.1.3 Potential for Increased 3R's Activity

Reduction

The major trend in passenger tire manufacturing and sales has been the move from bias ply tires to radials. Radials have extended the life of the tire by about three times that of bias ply tires thereby reducing the quantity of tire that would otherwise have been generated.[11]

Reuse

The high performance standards established by the radial tire and the popularity of all-weather use, has accelerated the demise of the passenger tire retread market.[12]

Dealers indicated aesthetics as well as economic barriers to higher retread sales in the passenger tire market. Those dealers that do sell retreads indicate that more retreads could be sold if marketing efforts were increased.[13]

Recycling

The cement industry in Ontario have long advocated the use of used tires as a fuel supplement in their cement kilns. It is estimated that Ontario's six major cement plants could consume approximately 13 million or 117,000 tonnes of tires annually.[14] However, the MOE's current position with regards to incineration makes it unlikely that the tires will be used as a fuel supplement.

The use of crumb rubber as an additive in asphalt formulations for road and highway applications represents a potentially large market. Rubberized asphalt has been tested throughout North America, including Ontario. However, the widespread application of rubberized asphalt has been limited by the need to carefully evaluate technical and economic performance factors. Premature general use of any paving system can result in expensive failures, especially for systems like rubberized asphalt that involve significantly higher initial costs than traditional asphalt.[15]

The Ontario Ministry of Transportation (MTO) is currently testing the technical performance of different mixes of rubberized asphalt. Assuming that the MTO approved the full-scale use of rubberized asphalt across Ontario, it is estimated that 9 million or 81,000 tonnes of passenger tire equivalents per year could be consumed.[16]

Chemical processing can be utilized to recover the chemical constituents through thermal or chemical degradation processes. The most well known example of chemical processing is pyrolysis which generates oil, gas and other products through thermal decomposition of tires in an oxygen-limited environment.

Pyrolysis has been tested extensively over the past 20 years by a number of large companies and U.S. federal agencies. However, pyrolysis has not historically proven to be technically and economically feasible under conditions similar to those in Ontario.[17] There are two Ontario companies that have been identified as researching pyrolysis process variations: Emery Associates in Bowmanville and Ibis Products Ltd. in Scarborough.[18]

17.2 Demand

17.2.1 Market Structure

The generators of scrap tires are mainly tire dealers and truck garages. About three-quarters of all scrap tires are generated by tire dealers. Tire jockeys collect tires from those who generate large volumes of tires and deliver them to either landfill sites, tire piles or directly to a tire recycler.

The costs of disposal to tire dealers which ranges from $0 to $5.00 per tire establishes a ceiling on what recyclers can charge scrap tire generators. Since tire dealers directly handle about 75 percent of scrap tires, those interested in recycling tires must charge less per tire than disposal costs. This is a major problem in regions with low waste management disposal costs.

The potential uses for scrap tires include whole tire retreading, chemical processing, physical processing and energy utilization.

Whole tire applications include retreading and resales. Other uses have been developed for whole tire reuse, including dock bumpers, highway crash barriers, playground equipment, erosion control and artificial reefs and breakwaters.

Physical processing involves reducing scrap tires into fine rubber granules called crumb rubber using either cryogenic or mechanical processes. Cryogenic processes utilize liquid nitrogen to freeze rubber prior to size reduction. The frozen rubber becomes brittle and readily shatter into small particles in a hammermill. This processes also provides for simple liberation and recovery of the wires and fabrics that are found in all tires.

There are three Ontario companies that have interests in cryogenic crumb rubber processing. Custom Cryogenics Grinding in Waterford has been cryogenically grinding rubber based waste materials into crumb rubber for eleven years. Custom uses only buffing dust and other rubber wastes from tire manufacturing as raw materials to control the polymer properties and quality of the friction brake pads they produce and sell in the U.S. Due to their formulation requirements, Custom Cryogenic will not used whole-tire crumb rubber unless growth in demand exceeds availability of current feedstock.[19]

Ontario Tire Recycling in Port Colborne is in the process of constructing a cryogenic system with a projected annual capacity of 1.2 million tires or 10,000 tonnes. Ontario Tire has estimated total operating costs to be about $0.18 per kilogram. The current tipping fee at their facility is $65 per tonne.[20] Just recently, it was reported that Ontario Tire had temporarily ceased operation due to storage problems that were identified by the MOE. It was also reported that Phillip Environmental of Hamilton had just recently purchased Ontario Tire and that operations were still shut down.[21]

The third cryogenic processor in the province is Recovery Technologies in Ayr. Recovery assumed the processing assets of Retico after its bankruptcy. Recovery is currently developing its production and marketing strategies prior to start up, and claims to have identified markets totalling 20,000 tonnes of crumb rubber. Recovery Technologies expects to achieve a plant capacity of 450 tonnes per month within 12 months of start up.[22]

Mechanical processors of crumb rubber use grinding and compression forces to produce tire granules. Resource Recovery in Orangeville started operations in early 1989 and is currently processing approximately 30,000 passenger tire equivalents per month (350,00 per year) or about 3,300 tonnes per year. The capital cost for the facility was $750,000, and the plant is operating with a tipping fee of $0.60 per tire.[23]

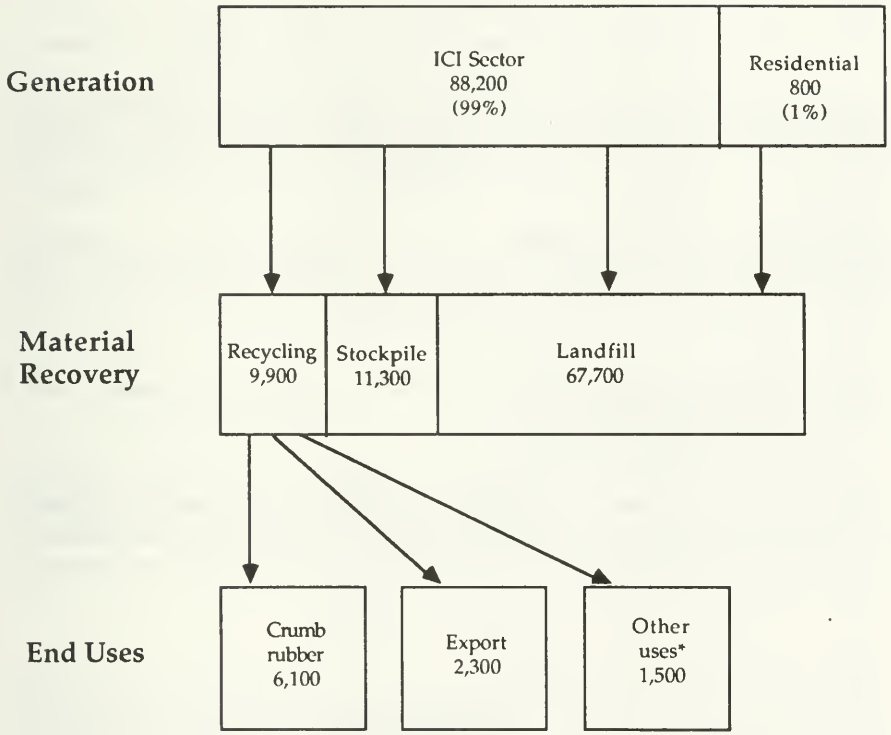
National Rubber Company in Toronto is the largest independent manufacturer of recycled masticated rubber products in North America. The majority of National Rubber's production is exported to the U.S., with 40 percent of its products made from recycled materials going to motor vehicle manufacturers.

National Rubber currently uses about 11,000 tonnes per year of vulcanized crumb rubber from scrap tires and 13,000 tonnes of other types of waste rubber. National Rubber purchases the majority of Ontario's current crumb rubber output, but available quantities represent only a small portion of their requirements. As a result, the company obtains over 80 percent of its tire-derived crumb rubber from the U.S.[24] National Rubber has submitted a proposal to the MOE which would increase its consumption for crumb rubber produced from Ontario sources.

Thermo Friction Waste Recycling Inc. (TWR) of Markham has been operating a demonstration facility which uses a series of thermal-friction-screw processes to produce crumb rubber. At an estimated capital cost of $2,970,000 or $483,300/yr (the annual cost amortized over 10 years at a 10% interest rate) for a plant processing 1.6 million tires per year into 15,000 tonnes of crumb rubber and operating costs of $0.165 per kilogram with a tipping fee of $0.80 per tire and crumb sales at $0.20 per kilogram this plant would generate revenues of approximately 1.4 million.[25]

Figure 17.1 provides a summary for Ontario markets for Scrap Tires.

Figure 17.1
Scrap Tires (tonnes per year)
Ontario 1989



* E.g. Docks, blasting mats etc.

17.2.2 Factors That Influence Demand

Factors that affect the demand for crumb rubber include quality of the processed material, adequate supply and relative pricing. Ontario is currently a net importer of crumb rubber. For example, National Rubber Company obtains over 80 percent of its crumb rubber from U.S. sources due to a lack of a reliable supply of crumb rubber in Ontario. National Rubber's expansion plans call for development of their own crumb rubber processing capabilities.

The traditional markets for crumb rubber generally include moulded rubber products, friction brake materials and pneumatic tires. Moulded rubber products for automotive uses and impact mats for industry or livestock offer a growing market for crumb rubber.

The automotive parts market represents the largest end market for moulded rubber products. As a result, a downturn in motor vehicle markets will impact the demand for moulded rubber products.

17.2.3 Factors That Influence Choice Between Primary and Secondary Material

Scrap tires do not compete or displace new tire products and applications. The applications for scrap tires and crumb rubber such as moulded rubber products or athletic surfaces or friction brake materials have traditionally been produced from scrap rubber products such as buffing dust and peeling from new tire manufacturing.

17.2.4 Price/Elasticity Analysis

Approximately seven to eight million scrap passenger car and truck tires are generated in Ontario each year. More than 80 percent of these end up in landfills. Fewer than 700,000 tires are recycled by processing them into raw materials for other products. Considerable attention is being devoted to reduction, reuse and recycling of scrap tires. This reflects concerns about decreasing availability of landfill capacity, potential fire risks associated with tire piles (where about 10 percent of the tires end up), and difficulty in landfilling tires, which tend to "float" to the surface of the landfill. In a recent survey of landfills, 38 percent of all landfills surveyed no longer accept scrap tires.[26]

Elasticity of Demand Issues

Although no studies dealing directly with the elasticity of demand for scrap tires were identified in the literature, a recent survey of management options for scrap tires in Ontario reviews the available technologies their relative costs, and considers the potential demand for tires associated with each end use.[27] Table 17.4 summarizes this information.

Table 17.4

Tire Disposal Options/Relative Costs/Demand Factors

End use/disposal option	Economically feasible tipping fee ($/tire)	Demand or factors influencing demand
Landfill	$0 to $1.30	Until recently, landfill was relatively inexpensive and readily available. More and more landfills are prohibiting disposal of tires.
Tire Derived Fuel (TDF)	$0.50 to $1.30	Disposal by means of TDF is a proven technology with relatively attractive economics and potentially large demand, but there are concerns about environmental performance and potential conflicts with 3R options.
Resale	-$27.50 to -$12.50 (will not have to pay tipping fee and will likely be paid if tire is in suitable condition for resale)	Capable of some expansion, but not likely to provide a significantly increased market in foreseeable future
End use/disposal option	**Economically feasible tipping fee ($/tire)**	**Demand or factors influencing demand**
Retread	-$2.35 to -$1.30	Capable of some expansion, but not likely to provide a significantly increased market in foreseeable future
Recycle–crumb rubber	$0.60 to $0.75	Potential demand for all Ontario tires. Requires financial support of users, manufacturing process development, and further product testing

Table 17.4, Cont'd.

Tire Disposal Options/Relative Costs/Demand Factors

Recycle — whole tire (e.g. artificial reefs, stabilizing mine tailings, landscaping, dock bumpers)	$2.00 to $3.00	Potentially significant demand, particularly for use on mine tails (50,000 tires per hectare). Technology is not well proven, costs considerably above traditional disposal
Recycle—highway asphalt	$2.00	Potential demand is approximately 9 million tires per year for 15 to 20 years. Requires technical demonstration. Thought to be less effective than conventional (less expensive) asphalt

The table indicates that for many of the 3R options, further technology development is required, and markets for the products will need to be developed. The province has been collecting $5.00 per tire since 1 June 1989, and has begun investing some of this revenue in research activities, and in market development.[27]

A number of policy measures have been identified which could encourage markets for scrap tires to expand:

- *funding market development initiatives* — market research and development studies, demonstration of new product applications, evaluation of environmental performance of technologies or products, export development.

- *implementing government procurement commitments* — providing preferences in purchasing (e.g. retreaded tires, rubberized asphalt in highway applications)

Elasticity of supply issues

Generators of scrap tires include tire dealers, auto wreckers and auto repair shops, and tire manufacturers. Experience at the Keele Valley landfill provides some indication of how supply is affected by price:

Table 17.5

Keele Valley Ontario Tipping Fee vs. Tires Disposed/Month

Period	Tipping fee per tonne	Change in tipping fee	Average tonnes of tires received per month	Change in average tonnes of tires received per month
1987 to March 1988	$18	0%	413	0%
April 1988 to April 1989	$50	170%	471	+14%
April 1989 to January 1990	$85	70%	275	-42%
February 1990 to March 1990 (post Hagersville fire)	$85	0%	400	+45%

Table 17.5 suggests that if tipping fees rise high enough, then the supply will decrease, however, this is premised on the availability of alternative destinations. After the Hagersville fire, it became increasingly difficult to find destinations for scrap tires, and disposal at Keele Valley increased, despite the higher tipping fee. With the relative unavailability of legal disposal sites, the costs for disposing of scrap tires has risen in some cases to as much as $10 per tire.[28]

The supply of tires is also affected by trends in types of tire sales. In the automobile tire sector, the shift from bias tires to radials has reduced the supply (because radials have a lifetime about three times longer). The shift to radials is largely complete now, and future supply of scrap tires is likely to mirror automobile registrations.

Finally, government policy is having and will continue to have a significant effect on the supply of scrap tires for recycling. Prohibitions on landfilling, "piling" and burning of tires will lead to increases in the willingness of generators to pay for tire removal, and will increase the economic viability of 3R options.

17.3 Assessment of Market Capacity to Absorb Supply

The capacity to absorb Ontario's annual generation of scrap tires will be reached before 2000. The unknown variable for scrap tires will be the tire piles. The new MOE guidelines for storing tires will likely increase the costs

of disposing the tires significantly either at landfills, tire piles or with recyclers.

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18.0 FOUNDRY SAND

18.1 Supply

The 1988 Ministry of Northern Development and Mines (MNDM) report entitled "The Foundry Industry in Ontario", identified that approximately 75% of Canada's foundry industry is situated in Ontario.[1] The foundry industries of Canada use at least four types of base metals - iron, steel, copper and aluminum, and also use a number of different casting technologies. In terms of capacity, the iron foundries represent approximately 95% of the foundry industry.[2] Two thirds of the foundry industry output is targeted for the automotive and truck market.[3] They also sell their product to a variety of other markets such as machinery and equipment, railway, and plumbing suppliers, etc.[4] When casting their products, Canadian foundries use large quantities of fine sands for mould-making. Sand reclamation is a process used to remove organic binders added to the sands to make casting moulds. Some foundries already have a reclamation process that recovers some of this sand for reuse but a significant amount of sand is still being targeted for disposal.

18.1.1 Generation by Sector

Current Generation

The foundry industries in Ontario are not consistent in size, capacity or processes and they have a number of different sand quantity requirements. Through discussions with industry representatives, it was realized that it would require contact with individual foundries in order to identify the actual quantity of sand that their process uses. However, there is information available on how much sand is sent for disposal by the foundry industry of Ontario as a whole. Therefore, for the purposes of this study, foundry sand generation is the amount of foundry sand actually disposed. In 1989, approximately 356,000 tonnes of foundry sands were disposed of in Ontario.[5]

These sands are disposed of by approximately 100-150 foundries in the province. There are 8-9 large scale foundries such as GMC, Chrysler, Ford, Dofasco and Kelsey-Hayes. GMC and Ford for example, are responsible for at least $^2/_3$ of the foundry sand disposed of in Ontario.[6] There are also about 30-40 medium scale foundries. These make up the approximately 50 foundries in Ontario that generate a significant amount of sand.[7] Iron foundries dominate the industry representing approximately 85% of Ontario's foundries.[8] In 1985, the iron foundries represented approximately 95% of the Ontario foundry industries total capacity, the steel foundries represented approximately 3% and the non-ferrous approximately 2%.[9] RIS has

concentrated on the iron sector of the foundry industry because, due to its significance both in number and in capacity, any changes in this sector will generally reflect the entire foundry industry.

Projected Generation

A number of foundries have ceased operations since 1980 and closures are expected to continue in the future. It is estimated that approximately 30 foundries ceased business between about 1980 and 1990.[10] There are a number of reasons for the decline in the foundry industry. Over the last 10-15 years, there has been a significant change in the demand for castings . The move in almost all sectors, such as the automotive industry has been towards smaller and lighter designs. Therefore, the heavy metal castings are being replaced with plastics and aluminum.[11] Heavy competition from import markets is also a factor in the foundry industry decline.[12] To fully understand the state of the foundry industry, it is necessary to look at the markets they serve as well. Two thirds of the iron foundry output is targeted for the automotive and truck market.[13] As stated in the MNDM report, the future of the Ontario industry in the global market is difficult to predict. Again competition from foreign automotive manufacturers and the unforeseen impacts of the Canada-US free trade agreement are two of the reasons for this difficulty.[14] The MNDM report projects that the automotive industry will remain flat resulting in limited investment in new foundry equipment by the automotive foundries.[15] The report also concludes that the Ontario foundry industry overall will likely experience a decline.[16]

Given a projected flat growth rate, RIS has set the amount of foundry sand generation in the years 1992 and 2000 at a maximum of 356,000 tonnes, or at the 1989 generation level.

18.1.2 Current and Projected Diversion Levels

Current Diversion

The two main technologies available for reclaiming spent foundry sands are mechanical reclamation, including the dry attrition process, and thermal reclamation. Dry attrition takes used moulds and cores and reduces them back to grain size, while removing the dust and fine particles from the sand. This method can feasibly restore 80% of the sand.[17] Thus, on average, mechanical reclamation requires that at least 20% new sand be added to reclaimed material before reuse. The MNDM survey of the steel foundries however, indicated an average recovery rate for mechanical reclamation of about 76%, less than the recovery rate quoted by the manufacturers.[18] Thermal reclamation is a process designed to completely remove chemical

contaminants. Theoretically, over 85% of the sand can be restored using this process.[19]

The 1988 Ministry of Northern Development and Mines (MNDM) report on the foundry industry surveyed the steel, iron and non-ferrous foundries in the province to determine, among other things, sand use and reclamation practices. The response they received captured approximately 95% of the iron foundries total capacity, 65% of the steel foundries total capacity and 50% of the non-ferrous foundry total capacity. Of the 32 iron foundries who responded 6 used mechanical reclamation. These 6 were said to be smaller foundries. Nine of the 11 steel foundries who responded also used mechanical reclamation. There was no data on the number of non-ferrous foundries who practice sand reclamation. Unfortunately, this report provided no information on the actual quantity of sand reclaimed. However, keeping in mind that the iron foundries are responsible for 95% of the foundry industry output, the reclamation in 6 small foundries is expected to be minimal.

It should be noted that the reclamation activities, as mentioned above, were initiated prior to 1989. Therefore, the generation estimate for 1989 is calculated after some degree of sand reclamation. The actual amount of sand reclaimed and diverted from landfills was not available.[20]

Projected Diversion

In order to project future diversion levels, RIS concentrated on the two main iron foundries, GMC and Ford. Since GMC and Ford dispose of approximately $^2/_3$ or 67% of the foundry sand in Ontario any reclamation programs they undertake will have a significant impact on disposal.

GMC is actively looking at the use of thermal reclamation in their foundry and expect the cost for such equipment to be in the range of $26 million.[21] GMC uses and disposes of approximately 500 tonnes of sand/day to make cores for their castings.[22] The number of days a week a foundry industry operates depends on the demand for their output.[23] For the purposes of this study, a 5 day work week is used, or 260 days/year. On this basis, the amount of sand disposed of by GMC is approximately 118,200 tonnes/year. It was expected, by the industry representative contacted, that even with sand reclamation there would still be losses of sand in the range of 20-30%. At a conservative 70% efficiency rate, a reclamation process at GMC has the potential to divert from a landfill approximately 82,700 tonnes of sand annually.

According to a representative from Ford, they are also investigating the possibility of reclaiming the 150 tonnes of new sand/day that they use and dispose.[24] Ford apparently has been looking at the feasibility of sand

reclamation for a few years but any action was held back as a result of the economic slow down.[25] However, due in a large part to increasing tipping fees, Ford feels that sand reclamation is becoming more economically viable.[26] Assuming 260 days of operation per year, Ford uses and disposes of 35,500 tonnes/year of foundry sand. Again assuming a 70% efficiency, sand reclamation equipment installed in the Ford foundry could divert approximately 24,900 tonnes for a landfill. Ford is looking at sand reclamation equipment costs in the range of about $10 million.

Since the two foundries contacted were unable to provide specific dates for the purchase of sand reclamation equipment, RIS has assumed that it would be unlikely for this equipment to be installed and operating by 1992. Therefore the projected diversion of 107,600 tonnes of foundry sands has been estimated for the year 2000.

Since 1989, the reclamation of foundry sands is occurring at the experimental level. GMC has a small pilot project in which they divert some sand to Steve Ranking Paving in Hamilton. Bibbi St. Croix sends about 50 tonnes of sand to Guelph Paving each week. It is assumed that these will continue into 1992. Therefore, diversion for 1992 is based on these experimental projects. It is unclear the exact quantity of sand diverted in the GMC project so the diversion for 1992 is calculated as approximately 2,600 tonnes, the estimated total amount diverted by Bibbi St. Croix.

18.1.3 Potential for Increased 3R's Activity

Reduction

The MNDM report indicates that more efficient moulding systems are slowly reducing the amount of sand used per tonne of good casting.[27] However, there is no indication of the quantity of this reduction. Permanent mould and lost foam technologies are two systems that are expanding into the automotive and machinery foundries.[28] Their use is growing fastest in the non-ferrous foundries, although technically they can also be used in iron foundries.[29] The use of these technologies has the potential to reduce the amount of sand by up to 90%.[30] However, this reduction will not be significant if the use of these new technologies does not spread into the iron foundries where the greatest percent of the sand is used.

Reuse

As landfill tipping fees increase throughout the province of Ontario more foundries will be faced with higher disposal costs for their foundry sands. This may serve to increase the incentive to use sand reclamation technology. Regional policies such as higher tipping fees are already identified as one of

the main pressures behind the foundry industries use of sand reclamation.[30] A foundry with dry attrition equipment can reduce the sand it must purchase and the sand it must dispose of by 70-80%. With a combination of dry attrition and thermal reclamation, a foundry can reduce by over 85% the need for purchases of new sand, and the need for disposal.

The equipment for sand reclamation however, is expensive. A case study from 1988 indicates that for a foundry using 1,000 tons of sand per year the capital cost for mechanical equipment would be approximately $150,000 and for mechanical and thermal combined approximately $270,000.[31] As mentioned, the systems for sand reclamation that are being considered by GMC and Ford could cost in the range of $26 million and $10 million dollars respectively. The current and future trends of the market, the cost of virgin material and the costs of disposal need to be weighed against the cost of reclamation equipment before any decisions are made by the foundry industry to install sand reclamation equipment.

The MNDM report on the foundry industry also gave some consideration to developing a central sand reclamation facility in Ontario. It indicated that such a facility could reclaim at least 75% of the foundry sand generated in the province.[32] However, during the casting process, each foundry requires a certain quality of sand and each foundry adds different substances to their sand. There is concern in the industry that a central reclamation facility may not be able to produce the quality of sand desired and that sand may become contaminated as a result of the wide variety of substances added at different foundries.[33]

Recycling

There may be opportunities for using sand disposed of by foundries in asphalt. At present, asphalt producers in Ontario use 40 million tonnes of sand each year. Before foundry sands could be used as asphalt, Provincial specifications for asphalt have to be changed. One of the problems is that foundry sands vary according to industry use and, as a result, particle size, heavy metal content and other contamination varies from load to load. The Canadian Foundry Association has been pressing the MOE to assist in revising these provincial specifications.

The Manufacturing Research Corporation of Ontario (MRCO) is presently working on the development and implementation of a sand exchange program for the province of Ontario. This work is being completed for the foundry industry and is confidential.[34] Therefore, the details of this program were unavailable.

18.2 Demand

18.2.1 Factors That Influence Demand

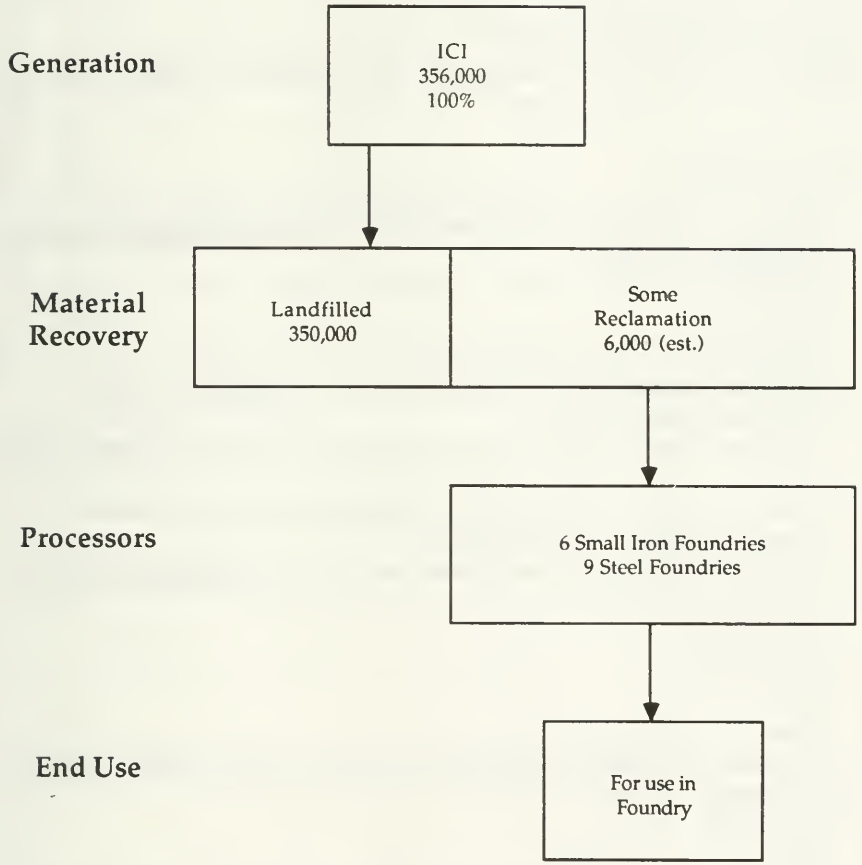
The demand for reclaimed foundry sand is primarily related to the cost of reclamation (capital and operating) compared to the cost of virgin material sand and disposal and indirectly to the strength of the automotive and truck markets, the main markets for the Ontario foundry industry.

The cost of sand represents only a small portion of the overall casting costs for the foundries. For example, in the iron foundries, the cost of sand is about 1.25% of the finished product.[35] The typical cost of silica sand ranges from $16.50-$24.20 per tonne plus transportation costs.[36] It is estimated that freight of raw materials, including sand, can range between 5-70% of the cost of the material itself.[37] Using the case study in the MNDM report, a foundry using 1,000 tons of sand per year at a cost of $24.20/tonne plus $8.80/tonne transport would have to pay an estimated capital cost of $150,000 for a mechanical reclamation system and an estimated capital cost of $270,000 for a combined mechanical and thermal reclamation system resulting in a pay-back period of 5.6 years and 8.7 years respectively.[38] The above case study is based on a landfill disposal cost of $11/tonne. The present landfill tipping fee in the region of Hamilton-Wentworth is $150/tonne or $165/tonne. With the increase in tipping fees, disposal has become a major cost of operating a foundry. In order to show the significance this tipping fee increase has on the feasibility of sand reclamation the updated disposal cost was applied to the above case study. It should be noted that the result of this application will not be completely accurate as it does not take into consideration any changes in the cost of reclamation equipment, virgin sand, and transportation. However, it should provide an idea of the economic significance of disposal cost increases. Applying the disposal costs of around $150/tonne to the above scenario would result in a payback period of approximately 1 year for mechanical reclamation and less than 2 years for mechanical and thermal combined. This relatively short payback period indicates that as the trend of landfill tipping fee increases continue in all areas of the Golden Horseshoe it becomes more economically feasible to install reclamation equipment.

Rising tipping fees are the main push for the foundry industry to move toward sand reclamation. However, as previously mentioned, this move will be heavily influenced by the strength of the market served by the foundries and the influx of new technologies which reduce the amount of sand used per tonne of good casting in the casting process.

Figure 18.1 provides a summary for Ontario markets for foundry sand.

FIGURE 18.1
Foundry Sand (tonnes per year)
Ontario 1989



18.3 Assessment of Market Capacity to Absorb Supply

The foundries of this province are capable of absorbing over 85% of the sand currently sent to landfill depending on the efficiency of their sand reclamation systems. With rising landfill costs, the cost of sand reclamation is becoming more cost/effective.

In addition there is the potential for the asphalt industry to absorb some of the foundry sand waste generated.

18.4 References

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3. Ibid., p.6.
4. Ibid., p.3.
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6. Personal Communication with Phil Kenney, Ortech International, May 1991.
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8. Ministry of Northern Development and Mines, The Foundry Industry in Ontario. 1988, p.6.
9. Ibid., p.3.
10. Ibid., p.20.
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12. Ibid
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14. Ibid., p.21.
15. Ibid
16. Ministry of Northern Development and Mines, The Foundry Industry in Ontario. 1988, p.20.
17. Ibid., p.18.
18. Ibid., p.29.
19. Ibid., p.18.
20. Personal Communication with Phil Kenney, Ortech International, May 1991.
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22. Ibid
23. Personal Communication with Phil Kenney, Ortech International, May 1991.
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25. Ibid
26. Ibid
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28. Ibid., p.11.
29. Ibid
30. Ibid
31. Ministry of Northern Development and Mines, The Foundry Industry in Ontario. 1988, p.19.
32. Ibid., p.18.
33. Personal Communication with Phil Kenney, Ortech International, May 1991.
34. Personal Communication with Chris Beaver, MRCO, April 1991.
35. Ministry of Northern Development and Mines, The Foundry Industry in Ontario. 1988, p.16.
36. Ibid., p.17.
37. Ibid., p.16.
38. Ibid., p.19.

19.0 MARKET DEVELOPMENT OPPORTUNITIES

19.1 Summary of Supply and Demand Forecasts

The generation and estimated diversion of the materials addressed in this study are summarized in Tables 19.1, 19.2 and 19.3 for 1989, 1992 and 2000 respectively. They are located at the end of this section. The tables indicate that given the waste policy environment in Ontario as of 1989, there is not a sufficient level of 3R activities to achieve the province's stated diversion targets of 25% by 1992 and 50% by 2000. However, it should be noted that two major initiatives are expected to play important roles in increasing waste diversion. These are the National Packaging Protocol (NAPP) and bans on sending selected materials to landfill which are becoming increasingly popular, particularly for municipalities within the GTA. These policies have not been fully factored into the analysis because their impact is difficult to anticipate. In particular, it is difficult to estimate how companies will select among the 3Rs, as well as material substitution, to meet NAPP's objectives.

There are specific areas where diversion is limited and substantial increases in waste reduction and recycling will be required to meet the targets. The following material categories provide the largest opportunities for increased waste diversion initiatives:

- fine paper from the ICI sector
- magazines from both sectors
- boxboard from the ICI sector
- glass containers from both sectors
- plastic film from both sectors
- food waste from both sectors
- yard waste from the residential sector
- wood waste from the ICI sector

Three main conclusions and suggested market development initiatives for each of these areas are discussed in the next sections.

19.2 Key Conclusions

Markets for secondary materials have existed historically for some materials. Paper is a prime example. In other instances, there has not been, nor is there yet, an established market for secondary materials; post-consumer boxboard is a good example.

A second key finding is that in many instances secondary materials are preferred for use in production because they have a price advantage over virgin materials. This advantage narrows as the price of virgin material drops. Because of these fluctuations, pricing advantages have been suggested

as a means of stimulating demand for secondary materials, which would also improve market stability.

Finally, this study, in conjunction with others, points to the need to obtain more accurate data on actual consumption of materials and how they are being diverted through the 3Rs. This need is particularly acute in the ICI sector, which has generally been responsible for managing its own wastes through private contractual arrangements. As the analysis demonstrates, a limited amount is known about what this sector is doing to divert wastes, and through which of the 3Rs. Moreover, much of the information is anecdotal in nature and cannot be construed as being a common approach across a given sector. The need for more definitive data is essential if the province is to have a better basis for decision-making in terms of the need for government stimulation of markets as well as to measure achievement of the stated targets.

In developing initiatives to stimulate markets for the current and anticipated upsurge in secondary materials, existing markets and their operation should be recognized. This does not mean that some form of government stimulus is not needed, rather the nature of the initiative and its impact on a well-functioning market should be carefully evaluated.

19.3 Recommended Initiatives for Market Development

The following sections discuss market development initiatives which the provincial government could undertake to stimulate markets to accommodate increased volumes of post-consumer secondary materials which are expected to be generated and for which there is a need to reprocess these materials to divert them from the waste stream.

19.3.1 Paper

There is a well-developed infrastructure of brokers and dealers in place for the recycling of paper. The industry has developed a common set of standards and known markets, both domestic and offshore, with market pricing mechanisms. What is new in the evolution of the markets for recycled paper is the emergence of residential (post-consumer waste) as a material source.

The pressure to have recycled content fibre in a wide range of papers, notably newsprint and fine papers is presently driving increased demand for these papers, stimulated primarily by customer requirements resulting from regulatory initiatives in the U.S. The short-term prognosis, as developed in this study, indicates a rapidly growing demand for these and other grades of most papers, with the exception of post-consumer boxboard. (This material presents particular difficulties because of contaminants such as glues, coatings etc. when it is converted into consumer packaging material.) This suggests

that the market will grow and stabilize over time, with rising prices. Thus, there appears to be less need for an interventionist policy role for most secondary paper materials.

Newspaper

In today's market, Ontario is in the unusual situation of being a net exporter of ONP. However, once all scheduled de-inking mills become operational, this situation will change, and Ontario will not be able to satisfy all provincial de-inking demand for ONP. Most mills will need to import feedstock materials from other sources such as the U.S., although transportation costs limit the range over which ONP will be sourced for any mill. Because of the transportation factor, it is expected that most ONP collected in Ontario will find domestic markets, however, some smaller sources of supply may be overlooked in the pursuit of larger quantity supplies. It is recommended that the Ontario government analyze this potential problem, and take action to ensure that Ontario mills will consume Ontario ONP.

Fine Paper

There is no need for government policy initiatives with respect to market demand, given the vast difference between local supply and demand in Ontario. There is a concern that the current lack of supply may tempt some end users to establish material purchasing agreements with less expensive, higher volume U.S. sources, instead of purchasing from Ontario collectors. It is recommended that this situation be monitored, and that appropriate action be taken to ensure that Ontario fibre is purchased locally. A critical factor to ensure markets for domestic post-consumer fine paper is to meet the established quality standards which are important to securing markets and obtaining good prices.

The overwhelming limitation in filling local demand for fine grades is the current lack of efficient office paper collection programs to recover these fibres. A significant percent of high grade paper generators are small office buildings. However, because these buildings do not, on an individual basis, generate enough paper to make regular collection cost-effective they are either ignored by businesses which offer collection services or they are charged a service fee per pick-up. As a result, the current marketplace arrangements discourage small generators from participating in a fine grade paper recycling program. Provincial government requirements for mandatory waste audits and action plans to increase diversion of waste should rectify this problem.

Corrugated Cardboard

OCC has an established market in Ontario which is capable of absorbing more domestic OCC than is currently diverted from the waste stream. As an established material for manufacturing paperboard and other materials such as sanitary paper and supplies for the construction industry, OCC will continue to be demand driven by these end uses. All industry sources including the Canadian Pulp and Paper Association and the American Paper Institute agree that demand for North American paperboard products is expected to remain strong in the 1990's. It is therefore expected that existing markets will be able to absorb all OCC recovered in Ontario. Under these conditions, government intervention in the marketplace to bolster or sustain OCC demand is not required.

However, improvements could be made on the supply side. Although many provincial municipalities have banned OCC from landfill, resulting in significant diversions from the large industrial and commercial sectors, other generators have not yet been addressed. Small and medium sized generators are often overlooked by collection firms because of the expense involved in collection. This results in loss of a substantial volume of material that could be recovered. Further, technological barriers to recycling fibres with hotmelt glues, certain coatings, glass contamination etc. prevent recycling of OCC generated from many sectors. Research into advancements to overcome these barriers should be selectively encouraged.

Magazines

Demand for waste magazines in Ontario will increase significantly in the near future as several newsprint recycling mills in Ontario and Quebec become operational and require the coated stock contained in magazines as an essential input to the paper making process. It is recognised that the hot melt glue bindings on magazines are a contaminant, and stepped up recovery should avoid these products until they can be dealt with. Ontario could take advantage of this market demand by developing a recovery system for post-consumer magazines. Magazines can be readily added to the existing blue box system and should occur in an orderly way to take advantage of the growing capacity for magazine grade.

Ontario needs to make certain that the magazine supply generated by Ontario sources will be accepted by the new de-inking mills. Currently, these mills are securing large supplies from U.S. industrial sources such as printers.

The Ontario Government should also encourage research into methods to reduce contamination. The development of recycling-friendly glue, for example, would make magazine grade more attractive to smaller de-inking facilities.

19.3.2 Plastics

Plastics comprise only 7% of the waste stream, yet because of their volume and the range of different resin types used, pose more complex problems for their recycling as secondary materials. The SPI recognizes many of these complexities, and is presently reviewing the need for and industry support for a centralized sortation facility in Ontario. Liaison with the SPI should be encouraged if the government plans any new initiatives to develop plastics markets.

There are three main factors that currently limit the potential for the use of post-consumer plastics in Ontario:

- costs of collection currently exceed potential revenues for most programs;
- there is no effective means of mechanically sorting plastics into resin groups;
- markets for reprocessed plastics are not highly developed.

The following are potential initiatives that may be taken by the Government of Ontario in order to increase the recovery and use of post-consumer plastics in the province:

Collection

- fund research into more effective means of collecting plastics (e.g. use of on-truck densifiers, retrofitting of trucks, etc.;

- consider providing subsidies to operators collecting plastics where revenues do not cover costs. These subsidies should be shared with private industry. Subsidies should only be provided on a short-term basis until secure, economically viable markets are developed. In theory, once a number of competing end markets come on stream, a higher value should be paid for post-consumer plastics at all points in the system. (This is already beginning to be the case for Ontario-based HDPE).

Sorting

- joint government/industry funding should be immediately applied to finding a solution to the sorting problem. It is highly unlikely that Superwood-type applications will have a large enough market to absorb all Ontario post-consumer plastics. Therefore, more feasible methods of sorting (i.e. mechanical sorting) are necessary.

The feasibility of developing a central sorting facility (or facilities) should also be investigated. Under this model programs could collect and bale mixed plastics and transport it to the central facility for sorting, thereby removing the sorting cost from the program operator. This would be especially appealing to smaller operators. The facility should ideally be located near to a plastics reprocessor to minimize transportation costs.

Market Development

- the Government of Ontario should institute procurement guidelines favouring products using recycled post-consumer plastics where possible;

- the government should also provide funding to potential end users to develop additional markets for recycled plastics.

There is currently research underway on improving collection and sorting technologies in both the U.S. and Canada. However, less is currently being done to guarantee end markets for the recycled material.

It is, therefore, recommended that the Province focus its efforts on helping to promote viable end markets for post-consumer plastics in Ontario.

19.3.3 Glass Containers

Glass containers are collected in all blue box programs in Ontario and glass reprocessing capability is available in Ontario at the Consumers Glass plant in Toronto. Key problems faced for increased diversion of glass is contaminants, and the growing volume of green glass given limited demand for this type of glass by end users. The following initiatives are recommended to increase glass recovery:

- Provide research support to municipal roads officials to develop glasphalt as a potential market for contaminated curbside collected glass.

- Work with municipalities to stimulate expanded recovery of glass from the ICI sector through increased voluntary support from the packaging industry and/or imposing mandatory recycling on large volume generators (bars, restaurants, cafeterias).

- Consider expanding the current regulations requiring a 50% recycling rate on non-refillable glass soft drink containers to include all non-refillable glass beverage containers (juice, wine, liquor, etc.)

19.3.4 Steel and Aluminum

There is no need for policy initiatives with respect to market demand, given the strength of both the secondary steel and aluminum markets. The concern is on the supply side, where the shift from aluminum to steel soft drink cans will negatively affect the economics of municipal curbside programs and render the recovery of cans from the ICI sector less viable. It is recommended that the provincial government enforce existing regulations requiring a true 50% recycling rate on non-refillable soft drink containers so that beverage companies consider the economics of recycling in their beverage container material choices.

19.3.5 Organics

Organics offer one of the greatest areas of potential diversion from the waste stream because of their share of total waste and their amenability composting. Recommendations stemming from the research into compost markets can be grouped into one of three groups: collection, processing and marketing.

Collection

The banning of yard waste from landfills is a strategy that has already been adopted by at least ten US states, including Illinois, Wisconsin and New Jersey. This measure represents a significant step towards established waste diversion targets which otherwise may not be achieved. As a result of these bans, especially in New Jersey and Illinois, municipalities have been very quick to respond with the initiation of yard waste collection programs.

It is recommended that the Ministry examine the impact of these yard waste bans more closely in order to determine possible ramifications of such a measure in this province. Should the collection/processing/marketing infrastructure be fully established before such a ban is enacted or should municipalities simply step back and expect private firms to respond to a ban?

The potential to mix yard waste collection with food waste also needs to be proven. In order to get 50% reduction, it is expected that all organics in the residential waste stream must be diverted from the landfill and this would suggest a more complex collection system possibly involving semi-automated carts and mechanized vehicles.

Given the number of Ontario municipalities already successfully operating leaf composting facilities, it appears that a mandating of a leaf landfill disposal ban in this province would soon be practical. Such a ban would be a natural precursor to a broader yard waste ban, followed much later by a full organics ban.

The collection of source separated food waste from restaurants, hotels and hospitals etc. is another area requiring more R & D. *It is recommended that the Ministry continue to examine in greater detail the diversion potential of food waste to animal feed.*

Processing

Since centralized composting is a relatively new activity in Ontario, it is recommended that the province develop an inventory of processing technologies and that this information be made available to both public and private sector operators. Further R & D may be required into the applicability of certain technologies in the colder climates of Ontario.

As with collection, some questions remain concerning the mixed processing of yard waste with food waste. Since food waste generally requires some kind of bulking agent, this would appear to be a good combination. Again, research into this area has probably been conducted elsewhere, however, *it is recommended that the Ministry become familiar with these systems and disseminate that information to key players.*

As with collection above, *it is recommended that rendering capacities be assessed to determine their ability to absorb source separated food wastes from the institutional, commercial and industrial sectors.*

Marketing

Based on the research conducted during this study, it is clear that further market development work is required in order to identify and quantify potential demand for compost products particularly as it relates to local conditions and needs. From a review of the literature and from discussions with various players it is apparent that compost marketing strategies are mostly lacking. Even in Illinois where yard waste was banned from all landfills on July 1, 1990, state officials "believe" that local users will simply absorb all compost.

While the private sector contains many potential end users of compost, much work is required to ascertain their willingness to switch from competing products that already meet their requirements. *It is recommended that the Ministry engage the private sector in ongoing discussions concerning their potential use of compost.*

In order to establish a broader understanding of the potential market for compost represented by the province's municipalities, *it is recommended that the province develop a data bank of the current consumption of topsoil, peat, mulch and other similar soil enhancement products.*

An additional unknown is the scale and depth of residential demand for compost products. In Section 13.0 it was noted that residential demand for compost in one New York community is roughly 20 kg/household/year. *It is recommended that the Ministry monitor compost giveaway programs in Ontario to determine their popularity with the general public.* Markham's program to sell compost should also be watched carefully since that is the first effort in Ontario to introduce leaf compost to the marketplace.

19.3.6 Wood

Wood waste is also a significant component of the waste stream. Wood waste has often been a co-product of the forest products sector for its use as a fuel or in paper making. Wood waste generated in the residential sector is often low in volume and as is also the case in the ICI sector, is co-mingled with other wastes. The main barrier to recycling wood waste is the lack of available intermediate processing capacity to convert bulky wood waste into marketable secondary products such as sawdust and wood chips. The provincial government, in conjunction with municipalities and private industry, should identify opportunities to support the implementation of wood waste processing facilities in major urban areas.

19.3.7 Scrap Tires

The government has already given financial support to establish suitable crumb rubber production in Ontario. Research and development for moulded rubber products and rubberized asphalts is now required to ensure economically viable end markets for crumb rubber.

19.3.8 Other Materials

Other materials including drywall, disposable diapers, and foundry sand are being addressed by the producers and/or generators of these products. It is not clear that at this stage, whether government assistance beyond R&D is required.

19.4 Summary

In order to achieve a 50% diversion of solid waste by 2000, a substantial level of market development activity will need to occur. The provincial government's role in stimulating markets may include:

- disseminating market information to suppliers and users of secondary materials;

- providing financial incentives to private industry to assist in the development of viable end markets;

- monitoring Ontario market development activities to ensure that Ontario supplies of post-consumer material are given preference;

- developing clear and equitable regulations for packaging and short term consumer goods waste diversion, including targets for recycling, reduction and reuse;

- instituting procurement guidelines favouring products made from post-consumer secondary materials, and encourage other levels of government to do the same.

- funding and encouraging research and development for innovative recycling technologies and means by which 3Rs activities may be enhanced.

Table 19.1

Summary of Material Generation and Diversion in Ontario, 1989

	1989 Residential			1989 ICI			Total 1989 Figures		
	Total Generated (t)	Total Diversion (t)	Rate of Diversion (%)	Total Generated (t)	Total Diversion (t)	Rate of Diversion (%)	Total Generated (t)	Total Diversion (t)	Rate of Diversion (%)
newspaper	400,000	155,900	39%	170,000	57,000	34%	570,000	217,900	38%
fine paper	74,000	0	0%	360,000	30,000	8%	434,000	30,000	7%
mixed paper	59,300	0	0%	79,400	0	0%	138,700	0	0%
boxboard	173,100	0	0%	333,900	0	0%	507,000	0	0%
occ	109,000	830	1%	441,200	110,300	25%	550,200	111,130	20%
magazines	165,100	260	0%	127,660	0	0%	292,760	260	0%
telephone books	13,000	750	6%	7,300	0	0%	20,300	750	4%
glass containers	268,500	31,000	12%	61,500	16,800	27%	330,000	47,800	14%
PET RPC	3,540	470	13%	390	0	0%	3,930	470	12%
HDPE RPC	17,440	460	3%	21,770	0	0%	39,210	460	1%
film	101,260	50	0%	56,960	0	0%	158,220	50	0%
other RPC	15,360	50	0%	23,180	0	0%	38,540	50	0%
aluminum cans	13,500	3,130	23%	15,400	5,434	35%	28,900	8,564	30%
aluminum foil	2,900	0	0%	1,300	0	0%	4,200	0	0%
tinplate steel cans	75,100	16,140	21%	24,600	60	0%	99,700	16,200	16%
diapers	111,000	0	0%	8,000	0	0%	119,000	0	0%
food waste	624,600	7,106	1%	490,000	30,000	6%	1,114,600	37,106	3%
yard waste	654,400	41,133	6%	110,000	0	0%	764,400	41,133	5%
wood waste	46,700	0	0%	1,439,700	0	0%	1,486,400	0	0%
drywall	11,500	0	0%	129,600	1,000	1%	141,100	1,000	1%
tires	800	0	0%	88,200	6,100	7%	89,000	6,100	7%
foundry sand	0	0	0%	356,000	0	0%	356,000	0	0%
other	1,113,100			1,014,940		0%	2,128,040	0	0%
TOTAL	4,053,200	257,279	6%	5,361,000	256,694	5%	9,414,200	518,973	6%

1989 total waste generation	9,414,200
1989 total estimated recovery	513,973
1989 estimated recovery rate	5%

0= unknown or not estimated

RPC = Rigid Plastic Container

Table 19.2
Summary of Estimated Material Generation and Diversion in Ontario, 1992

	1992 Residential			1992 ICI			Total 1992 Figures		
	Total Generated (t)	Total Diversion (t)	Rate of Diversion (%)	Total Generated (t)	Total Diversion (t)	Rate of Diversion (%)	Total Generated (t)	Total Diversion (t)	Rate of Diversion (%)
newspaper	385,000	307,800	80%	165,000	57,000	35%	550,000	364,800	66%
fine paper	77,400	19,365	25%	375,630	83,300	22%	453,030	102,665	23%
mixed paper	61,915	0	0%	82,890	15,700	19%	144,805	15,700	11%
boxboard	180,770	36,150	20%	348,695	0	0%	529,465	36,150	7%
occ	113,800	1,200	1%	460,900	138,300	30%	574,700	139,500	24%
magazines	173,100	14,964	9%	133,070	0	0%	306,170	14,964	5%
telephone books	13,570	2,435	18%	7,620	685	9%	21,190	3,120	15%
glass containers	276,600	87,000	31%	63,400	13,400	21%	340,000	100,400	30%
PET RPC	4,420	1,780	40%	490	100	20%	4,910	1,880	38%
HDPE RPC	22,600	3,950	17%	27,890	5,580	20%	50,490	9,530	19%
film	116,020	450	0%	65,260	0	0%	181,280	450	0%
other RPC	20,040	2,510	13%	29,720	5,940	20%	49,760	8,450	17%
aluminium cans	8,900	4,060	46%	12,300	6,445	52%	21,200	10,505	50%
foil	3,035	760	25%	1,360	0	0%	4,395	760	17%
tinplate cans	99,100	58,000	59%	40,600	9,512	23%	139,700	67,512	48%
diapers	115,900	17,400	15%	8,400	1,260	15%	124,300	18,660	15%
food waste	651,733	64,827	10%	512,000	95,450	19%	1,163,733	160,277	14%
yard waste	683,029	159,569	23%	114,000	0	0%	797,029	159,569	20%
wood waste	49,100	0	0%	1,503,300	188,000	13%	1,552,400	188,000	12%
drywall	12,000	0	0%	90,500	34,100	38%	102,500	34,100	33%
tires	840	0	0%	93,200	14,700	16%	94,040	14,700	16%
foundry sand	0	0	0%	356,000	2,600	1%	356,000	2,600	1%
other	1,163,128		0%	1,105,275		0%	2,268,403		0%
TOTAL	4,232,000	782,220	18%	5,597,500	672,072	12%	9,829,500	1,454,292	15%

1992 total estimated waste gen	9,829,500
1992 total estimated recovery	1,454,292
1992 estimated recovery rate	15%

0= unknown or not estimated

RPC = Rigid Plastic Container

Table 19.3

Summary of Estimated Material Generation and Diversion in Ontario, 2000

	2000 Residential			2000 ICI			Total 2000 Figures		
	Total Generated (t)	Total Diversion (t)	Rate of Diversion (%)	Total Generated (t)	Total Diversion (t)	Rate of Diversion (%)	Total Generated (t)	Total Diversion (t)	Rate of Diversion (%)
newspaper	420,000	390,000	93%	180,000	57,000	32%	600,000	447,000	75%
fine paper	84,100	42,100	50%	408,370	203,800	50%	492,470	245,900	50%
mixed paper	67,300	0	0%	90,120	15,700	17%	157,420	15,700	10%
boxboard	196,470	98,235	50%	379,000	0	0%	575,470	98,235	17%
occ	123,700	2,800	2%	501,100	250,500	50%	624,800	253,300	41%
magazines	188,200	52,675	28%	144,600	0	0%	332,800	52,675	16%
telephone books	14,750	6,365	43%	8,285	745	9%	23,035	7,110	31%
glass containers	299,500	140,000	47%	68,700	13,400	20%	368,200	153,400	42%
PET RPC	7,840	6,100	78%	870	260	30%	8,710	6,360	73%
HDPE RPC	45,010	18,000	40%	49,210	14,800	30%	94,220	32,800	35%
film	177,380	26,600	15%	99,780	15,000	15%	277,160	41,600	15%
other RPC	40,920	13,400	33%	52,440	15,640	30%	93,360	29,040	31%
aluminium cans	8,900	4,900	55%	12,300	6,679	54%	21,200	11,579	55%
foil	3,385	1,700	50%	1,520	0	0%	4,905	1,700	35%
tinplate cans	99,100	70,000	71%	40,600	11,480	28%	139,700	81,480	58%
diapers	126,000	18,900	15%	9,100	1,365	15%	135,100	20,265	15%
food waste	708,569	165,320	23%	557,000	159,768	29%	1,265,569	325,088	26%
yard waste	742,595	463,450	62%	124,000	0	0%	866,595	463,450	53%
wood waste	53,400	0	0%	1,634,400	328,000	20%	1,687,800	328,000	19%
drywall	13,100	0	0%	84,400	53,200	63%	97,500	53,200	55%
tires	900	0	0%	100,500	61,400	61%	101,400	61,400	61%
foundry sand	0	0	0%	356,000	107,600	30%	356,000	107,600	30%
other	1,179,981		0%	1,183,305		0%	2,363,286		0%
TOTAL	4,601,100	1,520,545	33%	6,085,600	1,316,337	22%	10,686,700	2,836,882	27%

2000 total waste generation	10,686,700
2000 total estimated recovery	2,836,882
2000 estimated recovery rate	27%

0= unknown or not estimated

RPC = Rigid Plastic Container

APPENDIX A

MARKETS FOR SECONDARY MATERIALS: THEORY AND EVIDENCE

1.0 *Introduction*

At the beginning of this project, a computerized literature search was conducted in an attempt to find both theoretical and empirical research in the field of markets for recycled materials. The databases searched were the Economic Literature Index, Foreign Trade and Economic Abstracts, Enviroline, Pollution Abstracts, the Environmental Bibliography and NTIS. In addition, articles found through this search were reviewed for useful references. A few authors of articles found through the computerized search, as well as members of the U.S. Environmental Protection Agency's Office of Solid Waste, were contacted by telephone in an attempt to include recently completed studies and work-in-progress in this review. A complete list of personal communications is available upon request.

The references produced by the literature search were found in the following types of sources:

- journal articles and books on the economics of conservation and waste management;
- trade magazines and journals;
- magazines and journals specializing in recycling and recovery;
- reports produced for governmental and independent bodies;
- comprehensive reports prepared for solid waste management authorities.

The following sections present the conclusions that were drawn from the review of the literature on each subject.

2.0 *GENERAL ATTRIBUTES OF MARKETS FOR SECONDARY MATERIALS*

2.1 *Market Structure*

A great deal of the literature on industrial organization is devoted to measuring how great an influence market structure can have upon firm conduct and firm and/or industry performance. Two issues examined in this literature are particularly relevant to the assessment of markets for secondary materials. These are:

i) What real or perceived benefits encourage firms to engage in horizontal integration of primary and secondary production and vertical integration into the collection and sorting of recyclable materials? and;

ii) What are the implications of such integration?

Industries producing and using primary products have historically tended to be oligopolistic and dominated by large vertically-integrated firms. Secondary industries have tended to be smaller, more competitive and less vertically-integrated (Page [1]; Grace, Turner and Walter,[2]). Recently however, there has been a trend towards the integration of primary and secondary production and towards vertical integration by secondary producers into the recovery of secondary materials (see for example the glass, aluminum, and drywall industries in Ontario. Vertical integration does not necessarily imply the acquisition of one firm by another. It can also be established by contractual relationship with virtually identical effects.)

Much of this integration can probably be explained as a reaction to the waste diversion legislation, disposal bans, and tipping fee increases that have lowered the prices of many secondary materials in several Canadian and American jurisdictions. These events are expected to increase the returns to members of industries producing and using recycled materials, and so, according to standard economic theory, entry into the industry will occur until excess profits are competed away.

Firms engaged in primary materials-based production usually face the lowest barriers to entry into secondary materials-based production. They often possess real cost advantages over other potential entrants because of complementarities in the production processes, distribution networks, or managerial expertise required by both types of firms. For example, in cases in which primary and secondary materials are almost perfect substitutes, firms engaged in primary materials-based production will have the advantage of not having to make risky investments in new production capacity in order to use secondary materials. Even in cases in which primary materials-based production processes cannot be easily adapted to use secondary materials, firms engaged in primary materials based production may have the advantage of greater relevant managerial expertise. Furthermore, these firms may be able to sell products containing secondary materials through existing channels and thus avoid new investment in distribution networks and sales personnel.

Firms engaged in secondary materials-based production are among the most likely entrants into secondary materials recovery because there are often significant benefits associated with vertical integration. Vertical integration reduces transactions costs (costs incurred by using the market) by

internalizing economic activity within the firm. In markets for secondary materials the risk caused by price volatility and uncertainty of supply represents a substantial transactions cost.

The literature also mentions that vertical integration might be used to increase the market power of the integrated firm (Blair and Kaserman, 1978)[3]. A small but highly specialized body of industrial organization literature has focused on the implications of horizontal or vertical integration into secondary materials markets by monopolistic primary producers. This research was almost entirely inspired by Judge Learned Hand's landmark decision in the Aluminum Company of America (Alcoa) case of 1945. Judge Hand decided that Alcoa's monopoly power in the primary aluminum industry was not restrained by the existence of a competitive secondary aluminum industry. See also Friedman (1967, 278-79), Gaskins (1974), Martin (1982), and Swan (1980). The findings of one of these studies are particularly interesting in light of the structure of some primary and secondary materials industries in Ontario (eg. aluminum).

Hollander and Laserre[4] found that if the cost of recycling was higher than the cost of primary production, (this may currently be the case in the production of canning sheet from UBC's as opposed to primary ingot (Apotheker, 1989, 21)[5], a monopolistic primary producer could maximize its profits by preempting entry into secondary production (by repurchasing all available scrap). They found that such entry preemption would cause price of both final products and secondary materials to rise since the monopolist would be forced to bid up the price of scrap.

One caveat which must be applied to this finding is that it is only completely valid within the rigorous specifications of the authors' theoretical model. Economists are still uncertain of how to model firm behaviour in oligopolistic industries.

2.2 *Supply*

Methodologies for modelling the supply decisions of municipal agents are still evolving. Several innovative techniques are embodied in this report. The literature review was of limited usefulness in developing these techniques because of the relatively recent entry of municipalities into the market and the uniqueness of the Ontario situation. However, the studies by Bingham, Cooley & Youngblood[6], and Research Triangle Institute (RTI) for the U.S. EPA (in progress) are worthy of note.

Using engineering data on a number of solid waste disposal and materials recovery options, Bingham, Cooley and Youngblood attempted to estimate

the elasticities of supply (as well as prices) for paper, glass, ferrous metals, aluminum and energy recovered from U.S. municipalities. Their key assumption was that the municipalities would attempt to minimize net disposal costs. Unfortunately their findings are not particularly relevant to the current situation as only centralized materials recovery techniques were examined. In fact, collection costs were ignored in the analysis.

The own-price and cross-elasticities of supply estimated by Bingham, Cooley and Youngblood are shown in Table A-1. For example, the own-price elasticity of supply for aluminum is 0.730 and the cross-price elasticity with respect to steel is 0.251. This means that a 10 per cent increase in the price of aluminum would result in a 7.3 per cent increase in the supply from municipalities. The strong cross price effect with respect to steel shows that to a certain extent, similar facilities are required to separate aluminum and steel from municipal solid waste and so a 10 per cent increase in the price of steel would result in a 2.51 per cent increase in the supply of aluminum. The supply curve described by the elasticities below is a long run supply curve and its shape is only accurate to the extent that the costs of the various materials recovery techniques and the behaviour of municipal decision makers are accurately estimated by the model.

Table A-1

Elasticities of Supply for Secondary Materials Recovered from Municipal Solid Waste

	Paper	Glass	Steel	Aluminum	Energy
Paper	1.05	0.0	0.0	0.0	0.0
Glass	0.029	0.165	0.155	0.151	0.013
Steel	0.051	0.047	0.372	0.240	0.056
Aluminum	0.037	0.041	0.251	0.730	0.042
Energy	-0.80	0.002	0.019	0.020	0.234

Source: Bingham, Youngblood, and Cooley (1983, 176)

In contrast with the Bingham, Youngblood and Cooley study, RTI's recent study for the EPA does not assume that municipalities will attempt to minimize disposal costs in their choice of recycling programs. Instead they assume that the choices made by municipalities in the near future will be very much like the choices made by similar (in terms of size and population density) municipalities in the recent past. In other words, they assume that the future distribution of choices across the range of available options will be similar to the past distribution of such choices.

The recent emergence of municipalities as the most significant suppliers of many secondary materials has weakened the justification for focusing upon price as the most important determinant of the quantities of secondary materials supplied. It seems inappropriate to assume that price or profit is the major factor in the decision-making process of municipal agents. Factors such as public or legislative pressure requiring diversion of solid waste from landfill (which effectively increases the avoided costs of disposal), waste generation rates and the fact that recycling programs are viewed primarily as a form of waste management rather than revenue generation will probably all combine to ensure that municipal supply is less responsive to changes in price than was supply from previous sources. However, initial choices of materials recovery techniques will almost definitely take expected revenues and costs into account. Thus, cost-based supply curves may still be appropriate when considering the medium to long run.

2.3 *Demand*

In order to understand the demand for secondary materials it is important to identify all the points in the production process at which secondary materials might be consumed or substituted for primary materials. A schematic representation of materials flows in the economy based upon one found in Anderson and Spiegelman[7] is included in section 3.1. At each point the elasticity of demand for the secondary materials will be determined by their substitutability for the corresponding primary materials, the substitutability of other competitive materials and the elasticity of demand for the final product. The weight of each of these factors will vary from point to point.

The elasticity of demand will also vary depending upon whether or not it is considered over the short or long run. In the short run, little or no investment in new technology or capacity is possible and so demand is likely to be fairly inelastic. However, in the long run, greater substitution is possible since old equipment can be allowed to depreciate, and then replaced with different technology, or capacity embodying new technology can be added to accommodate increased demand. In very capital-intensive industries, the nature of installed capacity (whether or not it is easily adapted to the use of secondary materials) will be a significant determinant of the short-run demand for secondary materials.

A number of attempts to estimate elasticities of demand for certain secondary materials using econometric methods are reviewed in section 4. No attempts to estimate such elasticities using engineering data were found.

Since the demand for secondary materials is a derived demand, within certain limits (until the price is such that substitution becomes feasible),

demand for the final product is often the most significant influence upon their demand. Demand for the final product will also be the most significant influence upon demand for secondary materials if they are materials of last resort, ie. they are only used in periods in which there is a shortage of primary production capacity. In support of this hypothesis, Deadman, Turner and Grace[8], Gill & Lahiri[9] and Kinkley & Lahiri[10] found price to be statistically insignificant as a determinant of demand for wastepaper. Parameters related to the demand for wood pulp and mill products were found to be more significant.

Other factors

Three other factors have been identified in the literature as potential influences upon the demand for secondary materials. First of all, relatively valuable secondary materials such as aluminum, most paper grades and some plastic resins can economically be transported to export markets. Foreign demand will depend upon transportation costs, market conditions in the foreign country and any barriers to trade that might exist between the two countries. Grace, Turner, and Walter and Yohe[11] suggest that international trade can help to stabilize the prices of secondary materials.

Secondly, fundamental economic changes can considerably alter the demand for recycled materials. To the extent that primary or secondary material production or use is intensive in a factor such as labour, energy or capital, changes in relative factor prices will alter the pattern of demand. The United States Congress Office of Technology Assessment[12] reviewed estimates of the relative energy use of primary and secondary materials-based production. Secondary materials-based production produced clear energy savings in the aluminum (90-95%), glass (31%), steel (47-59%) and plastics (92-98%) industries. The energy savings estimate for plastics does not take into account the costs of collecting and transporting recycled resins. The estimates for all other materials are based on total energy use involved in either primary or secondary materials-based production, not only energy used in processing the materials. The production of newsprint from de-inked newspaper was estimated to use 10-23% less energy than production from primary pulp, however, there was disagreement over whether secondary fibre use resulted in any energy savings in the production of linerboard and the use of secondary fibre was found to increase energy use in tissue production.

Thirdly, public policy can also play an important role in the demand for secondary materials. Favourable tax structures and freight rates for primary materials are often cited as depressants of demand for recycled materials. The inefficiency inherent in the current price structure also favours primary materials. At present, the price structure does not include disposal costs in the prices of primary materials while costs of collection are included in the

price of recycled materials and avoided disposal costs are often ignored. Studies of the possible remedies for these and other inefficiencies in current public policy are examined in section 5.

Fluctuations in Demand and Price Volatility

Both primary and secondary materials are subject to fairly large fluctuations in demand because of fluctuations in the output of goods in whose production they are used. In addition the demand for some secondary materials fluctuates more than that for equivalent primary materials because many primary production processes are more capital-intensive and more expensive to restart once shut down than secondary production processes (eg. secondary smelters versus potlines in the aluminum industry).

Large variations in demand combined with inelastic supply have resulted in very volatile prices for most secondary materials. However, the volatility of these prices relative to those of primary materials might be overstated. After examining data from 1970 and 1971, Page was unable to confirm that prices of secondary aluminum ingot were any more volatile than primary ingot prices. He noted that the fact that primary producers often give secret discounts from the published list prices of their products and only rarely change their list prices might conceal much of the variation in the actual prices paid for primary materials.

Several authors have examined the possibility that the volatility of secondary materials prices has resulted in risk-averse behaviour on the part of suppliers and thus reduced investment in the recycling industry (see for example Butlin,[13]).

3.0 STATISTICAL DATA

Only the wastepaper, glass cullet, and ferrous scrap markets are sufficiently established in Ontario to provide adequate data for econometric analysis. American data on the market for UBC's is also available.

The following types of information are required in order to estimate demand functions for secondary materials:

- prices of secondary materials;
- consumption of secondary materials by enduse;
- prices of primary materials;

- consumption of primary materials by enduse;
- total output in each enduse.

Secondary Material Prices

Robert Boulanger, the publisher of Recoup, has offered to make the price data published in Recoup available in machine-readable form for a nominal charge. The data consists of:

- 12 years of prices of all paper grades;
- 10 years of (U.S.) prices of UBC's;
- 10-12 years of prices for ferrous scrap.

Prices paid for tinplate steel cans and container glass are available from the Canadian Tinplate Recycling Council.

Consumption of Secondary Materials by Enduse

Data on consumption of wastepaper by enduse is not yet collected by the CPPA. Total consumption by paper grade is classified as confidential information by the CPPA. However, some of this data has been released to certain government officials.

Prices of Primary Materials

Industry price indexes are published monthly by Statistics Canada (cat. 62-011).

Consumption of Primary Materials by Enduse

Wood pulp consumption by enduse is available from the CPPA.

Total Output in Each Enduse

Output of paper products is available on a monthly basis from the CPPA. Annual figures on shipments of cans and canning sheet in the USA are contained in Apotheker.

The value of glass products is published by Statistics Canada (cat. 44-207) on a national basis.

National steel production is published by Statistics Canada (cat. 41-001).

4.0 ECONOMIC STUDIES

Econometric methods can be used to estimate demand and supply functions and their corresponding elasticities. However, Page (pp 47-48) suggests five reasons why econometric analysis may be less than successful when applied to secondary materials markets:

- the poor quality of price and quantity data;
- the dynamic short-run nature of the supply for most secondary materials;
- the importance of technological change in many of the industries and the difficulties in accounting for this econometrically;
- important nonlinearities (which are also difficult to model econometrically) in the supply of secondary materials;
- the distorting effects of government programs and policies.

Holmes[14] also notes that the use of a single parametric value such as an elasticity of substitution to describe the relationship between input prices and demand presumes that the relationship between price and substitution is both continuous and reversible. However, this presumption may be unwarranted since:

- certain substitution decisions may be irreversible;
- the relationship between input prices and demand may be discontinuous and demand might be unresponsive to price within certain ranges if only a few different production technologies are available.

4.1 Demand Functions

The demand function for secondary materials can be estimated using econometric methods. To do so, a regression analysis is performed with quantity demanded as the dependent variable and with parameters such as the material's own price, the price and output of the final product, the price and output of competing primary materials and primary production capacity as the independent variables.

An estimate of the own-price elasticity of demand can be derived from the results of the regression analysis. This elasticity measures the degree to which demand varies in response to changes in the price of the good.

$$\Sigma D_i = (\Delta Q_i / Q_i)\,(P_i / \Delta P_i)$$

is the elasticity of demand for good i where Q_i and P_i are the quantity and price of good i, and Δ denotes the change in price or quantity. If ΣD_i is > 1

then the price elasticity is considered to be elastic and the demand curve is relatively flat. If ΣD_i is < 1 then the price elasticity is considered to be inelastic and the demand curve is relatively steep.

Attempts to estimate the elasticity of demand for certain secondary materials have been made by Anderson and Spiegelman, the Environmental Law Institute, Research Triangle Institute and Russell & Vaughan[15]. These are summarized in Table A-3. Kinkley and Lahiri and Gill and Lahiri found the price of wastepaper to be a statistically insignificant parameter in their demand functions (implying a zero own-price elasticity). These results are now somewhat dated and so technological changes, and the effects of government policy must be taken into account.

Future demand can also be estimated by relating forecasts of the production of final products to technical input-output coefficients for secondary materials. Specifically, the matrix of technical coefficients is multiplied by a final demand vector to produce the estimate of future demand. Turner, Grace and Walter employed this approach to estimate future demand for wastepaper in the EEC, the United Kingdom, and the USA.

Table A-2

Review of Published Estimates of Elasticities of Demand for Secondary Materials

Author	County	Wastepaper		Ferrous Scrap	
		Elasticity	Years	Elasticity	Years
Anderson & Spiegelman	USA	0.08	1962-1974	-0.64	1962-1972
Environmental Law Institute					
Research Triangle Institute					

Table A-3

Estimates of the Elasticities of Demand for Ferrous Scrap in the USA

Plant Type	Cross-Elasticity of Demand Between Scrap and Iron Ore
Open Hearth	0.52
Basic Oxygen	0.03
Basic Oxygen/Electric Arc Combination with 100% Excess Capacity	0.39

Source: Russell and Vaughan (1976, 242)

4.2 *Supply Functions*

This section contains a brief review of attempts to estimate supply functions and elasticities of supply for wastepaper and ferrous scrap. The elasticity of supply of a good measures the degree to which supply varies in response to changes in the price of the good.

$$\Sigma S_i=(\Delta Q_i/Q_i)\,(P_i/\Delta P_i)$$

is the elasticity of supply for good i where Q_i and P_i are the quantity and price of good i, and Δ denotes the change in price or quantity. The elasticity of supply can be related to the slope of the supply curve. If ΣS_i is > 1 then the price elasticity is considered to be elastic and the demand curve is relatively flat. If ΣS_i is < 1 then the price elasticity is considered to be inelastic and the supply curve is relatively steep.

Because of the recent entry of municipalities into the markets for secondary materials, and the fact that the studies on wastepaper did not distinguish between the different grades of paper, the results presented below are not very useful in understanding current markets.

Wastepaper

A number of studies have been made of the elasticity of supply for wastepaper and ferrous scrap, as summarized in Table A-4. All the studies agreed that the supply of wastepaper was quite inelastic in both the United Kingdom and the USA. See Anderson and Spiegelman (1977), Deadman and Turner (1981),

Edwards (1979), Edwards and Pearce (1978), Gill and Lahiri (1980), and Kinkley and Lahiri (1984).

Anderson and Spiegelman included both current and past prices in their supply equation. They found that current prices had a positive coefficient in the supply equation, while past prices had a negative coefficient.

Other studies experimented with different formulations of price expectations. Edwards and Pearce[16] used an adaptive expectations framework. Kinkley and Lahiri used a rational expectations hypothesis.

Ferrous Scrap

Using data from May 1962 to December 1972, Anderson and Spiegelman found that the short run elasticity of supply for ferrous scrap was 1.43, while the long run elasticity was 1.12.

Table A-4

Review of Published Estimates of Elasticities of Supply for Wastepaper

Author	Country	Years	Elasticity
Anderson	USA	1962-1974	0.49
Anderson & Spiegelman	USA	1962-1974	0.40*
Deadman, Turner & Grace	UK	1968-1976	"low"
Edwards and Edwards & Pierce	USA	1947-1973	0.30
Gill & Lahiri	USA	1952-1974	0.19
Kinkley & Lahiri	USA	1960-1978	0.23
Research Triangle Institute	USA		0.09

* Long-run elasticity of supply. Elasticity with respect to current price was 0.53.

4.3 *Cross-Price Elasticities*

Cross-price elasticities, often referred to as simply 'cross -elasticities', relate the change in the demand for a good to changes in the price of other goods.

$$\Sigma D_{ij}=(\Delta Q_i/Q_i)\ (P_j/\Delta P_j)$$

is the cross elasticity of demand for good with respect to good j. It measures the percentage change in demand for good i resulting from a change in the price of good j. A positive cross elasticity usually indicates that goods i and j are substitutes because a rise in the price of j results in a decrease in its consumption and its substitution by good i (the relatively cheaper good).

Cross elasticities for certain secondary materials have been estimated by Anderson & Spiegelman, the Environmental Law Institute, Gill & Lahiri and Russell & Vaughan. In the absence of significant variation in the price of wood pulp, Kinkley and Lahiri estimated the coefficient of total consumption of wood pulp in the demand function.

Table A-5

Review of Published Estimates of Cross-Elasticities of Demand for Secondary Materials

Author	Material	
	Wastepaper	Ferrous Scrap
Anderson & Spiegelman	0.17	1.14*
Environmental Law Institute	0.13	0.28
Gill & Lahiri	0.20	-----

* Elasticity with respect to steel production rather than prices.

Using engineering data, Russell and Vaughan (1976) estimated cross-elasticities of demand between scrap and iron ore in the United States for three different types of plants. Their estimates are shown on Table A-6.

Table A-6

Cross-Elasticities of Demand Between Ferrous Scrap and Iron Ore

Plant Type	Cross-Elasticity of Demand Between Scrap and Iron Ore
Open Hearth	0.52
Basic Oxygen	0.03
Basic Oxygen/Electric Arc Combination with 100% Excess Capacity	

Source: Russell and Vaughan (1976, 242)

4.4 *Elasticities of Substitution*

Elasticity of substitution is a measure of the extent to which the ratio of inputs used in a production process changes in response to a change in the relative prices.

$$\Sigma\partial_{ij}=(\Delta(Q_i/Qj)\Delta(P_iP_j))\ ((P_iP_j)/(Q_iQ_j))$$

is the elasticity of substitution between goods i and j. With production processes capable only of a fixed input ratio, input ratios will not change in response to relative price changes and ∂_{ij} will equal zero. With more flexible production processes, the elasticity of substitution is greater.

No estimates of elasticities of substitution between primary and secondary materials were found in the literature although such analyses have been performed for a number of raw materials and other factors of production. For examples, see references in Slade (1981) and Holmes (1988). One major obstacle to performing a similar analysis involving secondary materials is the poor quality of the available price and quantity data. Holmes (1988) identifies a number of additional problems with such analyses, three of which might be particularly relevant in the case of many secondary materials. He argues that the following factors play important roles in materials substitution but cannot be adequately accounted for using econometric techniques:

- relative input prices may influence technical innovation by inspiring research and development aimed at economizing upon the relatively expensive factor of production. (Holmes cites two studies of materials substitution in American tin-using industries which observed this effect.)

- uncertainty of supply can reduce demand for a given input, particularly when substitution decisions are not easily reversible.

- consumer attitudes (such as a preferences for, or aversion to, recycled material content) might play an important role in final product demand and hence substitution decisions.

In some cases, interviews with industry representatives, or estimates based upon engineering data might be more appropriate methods of determining the long-term relationship between price and substitution than regression analysis and the estimation of unqualified values such as elasticities of substitution.

5.0 POLICY

A number of authors have attempted to analyze the effectiveness of various policy initiatives designed to affect the level of recycling activity in a given economy. For the purposes of this study, only the impacts that various policy initiatives would have upon markets for secondary materials, rather than the economy as a whole, were examined.

Attempts have been made to examine the effects of the following types of policies:

- elimination of tax policies favouring primary materials;
- elimination of preferential freight rates for primary materials;
- subsidization of either producers or users of goods containing secondary materials;
- price stabilization schemes;
- recycled content legislation.

Elimination of Unfavourable Tax Policies

Several studies conducted in the 1970's, and Gill and Lahiri in 1980, examined the effects of the United States' favourable tax policies for virgin materials on the markets for secondary materials. These policies included the percentage depletion allowances for minerals, oil, and gas, and the special treatment of income for the timber industry. Below-cost government timber sales and support from the U.S. Department of Agriculture are also important federal subsidies to the lumber industry. No studies have been made of the effects of tax policies upon the secondary glass and plastics industries. Table A-7 summarizes the results of these studies.

All the studies concluded that the removal of the subsidies to the mining and forestry industries would not greatly affect the demand for secondary materials and many noted that such significant changes to the tax code would be very difficult to accomplish. In fact, use of secondary materials has increased faster than predicted by any of the studies (U.S. Congress Office of Technology Assessment, 1989, 201). These results are now somewhat dated and so changes in the U.S. tax code and current conditions must be taken into account.

Table A-7

Estimated Effects of Tax Subsidies on Virgin Materials Prices and of Eliminating Virgin Materials Subsidies on Use of Secondary Materials

Material	Effects on Prices of Virgin Materials		Increase in Secondary Material Use
	Maximum Possible Impact	Most Likely Impact	
Paper	+4.2%	+1.0%	0.04-0.06%
Steel	+3.0%	+2.0%	0.4-2.0%
Aluminum	+2.2%	----	1.0%

Source: U.S. Congress Office of Technology Assessment (1989).

Preferential Freight Rates

In the United States in the mid to late 1970's, some groups expressed concerns that virgin materials producers obtained preferential freight rates from U.S. railways. Page (ch. 4) describes the efforts by American recycling organizations to force the U.S. Interstate Transit Commission (ICC) to reverse its allegedly discriminatory rate structure however he was unable to present any estimates of the impact of preferential freight rates on markets for secondary materials. Gill and Lahiri predicted that the elimination of preferential rail freights for primary materials would have little or no effect on the use of recycled materials.

Recycling Subsidies

Anderson (1977)[18], Anderson and Spiegelman (1977) and Gill and Lahiri (1980) all examined the likely effects of the direct subsidization of either secondary materials suppliers or users that was proposed in the United States (H.R. 148 and H.R. 10612). They concluded that such subsidization would be difficult to justify in an economic context unless the social costs of unrecovered scrap materials exceeded existing market values by a factor of several hundred per cent. A significant problem with the proposed subsidies was the fact that they would be paid to users of both pre- and post-consumer secondary materials.

Price Stabilization Schemes

Concerns that large price fluctuations were deterring municipalities from engaging in recycling activities sparked interest in price stabilization schemes for secondary materials. The most commonly suggested methods were the use of buffer stocks and futures exchanges, although long-term contracts (with minimum and/or maximum prices) or buffer funds can have similar effects.

Buffer stocks have been used to dampen price fluctuations in the wastepaper markets in Japan, the Netherlands, and Norway but were rejected in Belgium and the UK (Turner, Grace and Pearce, 1977). Stocks are accumulated in times of low demand and resold in times of high demand. Turner, Grace and Pearce were unable to prove that a hypothetical buffer stock scheme in the United Kingdom would have benefitted municipalities involved in recycling wastepaper. It is also theoretically possible for buffer stock schemes to destabilize income (Butlin, 1977, 226).

Both empirical and theoretical literature have shown futures exchanges can improve the efficiency of commodity markets by allowing commodity users to hedge their purchases and speculators to assume price risk. Anderson and Dower (1978)[19] suggested that futures markets for secondary materials might improve the efficiency of the markets for these commodities. However O'Neill, (1983)[20] using econometric methods and monthly data on inventories and sales in the USA (1962-1980) found that the theoretical efficiency of the market for ferrous scrap was very high. He also noted that the prices of secondary materials which are readily substitutable for the primary materials, eg. copper, plastic and aluminum, follow those of the primary materials very closely. Thus, these markets were likely to be just as efficient as those for the primary materials (O'Neill describes the market for the primary commodity as a "ghost" futures exchange for the secondary commodity.)

Butlin (1977) notes that buffer funds (which withhold earnings in buoyant markets and support prices in depressed markets) can destabilize rather than stabilize markets under certain conditions, particularly when the elasticity of supply is unknown (Butlin, 1977, 225).

Recycled Content and Waste Diversion Legislation

The policies discussed above are all directed at affecting the relative prices of secondary materials. Most of the authors cited questioned the effectiveness of any price-oriented policies in affecting the use of secondary materials because of the very low elasticities of supply estimated by their models. However, the supply side of the market has changed so radically in recent years that the validity of their conclusions is now questionable.

Despite the number of states considering its adoption, relatively little research into the effects of recycled content legislation upon markets for secondary materials has appeared. The potential impact of recycled content legislation on the market for old newspaper, and of waste diversion legislation on the markets for a number of secondary materials, are currently being studied by the Research Triangle Institute for the US EPA.

6.0 References

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APPENDIX B

PROJECTED DEMOGRAPHICS FOR ONTARIO

Projected Demographics for Ontario

This appendix develops the population and household numbers used to generate the waste estimates in the report. In the 1990 Ontario Municipal Directory, population and household data are provided for each municipality, county and district in the province for 1988. For the purposes of projecting these figures to the year 2000, two assumptions are made:

- the number of people per household (population density) remains constant throughout this time period, and
- population growth is evenly distributed across all Ontario jurisdictions.

The Ontario Ministry of Treasury and Economics has provided the Ministry of the Environment with total population projections for 1992 and 2000. CH_2M Hill has provided the population for 1989. These are as follows:

Year	Estimated Pop.
1989	9,598,600
1992	10,022,000
2000	10,896,000

Therefore, to determine the corresponding number of households for these years, both the distribution of population and the population densities from 1988 are applied against these estimated population totals.

For example, take the 1988 population of Metro Toronto and divide it into the 1988 Ontario population; multiply the dividend by the projected 1989 Ontario population in order to derive a 1989 estimate for Metro Toronto's population. To calculate the number of 1989 households, take the 1988 population density figure (or ratio) and divide it into the new 1989 population estimate. The same procedure is applied again for the 1992 and 2000 projections.

PROJECTED DEMOGRAPHICS FOR ONTARIO

	1989 hhlds.	1989 pop.	1992 hhlds.	1992 pop.	2000 hhlds.	2000 pop.
METROPOLITAN MUNICIPALITY						
Metro Toronto	912,795	2,260,764	953,058	2,360,487	1,036,173	2,566,341
REGIONAL MUNICIPALITIES						
Durham	129,333	368,575	135,038	384,833	146,814	418,394
Haldimand-Norfolk	38,994	94,545	40,714	98,715	44,265	107,324
Halton	103,657	298,461	108,230	311,627	117,668	338,803
Hamilton-Wentworth	176,019	455,071	183,783	475,145	199,811	516,581
Niagara	154,096	386,970	160,894	404,040	174,925	439,275
Ottawa-Carleton	273,652	660,287	285,723	689,412	310,641	749,535
Peel	213,679	644,596	223,104	673,029	242,561	731,723
Sudbury	61,802	160,335	64,529	167,408	70,156	182,007
Waterloo	133,411	362,422	139,295	378,409	151,443	411,409
York	136,013	433,694	142,013	452,825	154,397	492,315
DISTRICT MUNICIPALITY						
Muskoka	38,026	42,340	39,703	44,208	43,165	48,063
COUNTIES						
Brant (Brantford)	40,947	108,171	42,753	112,943	46,482	122,792
Bruce	32,915	60,524	34,367	63,194	37,364	68,705
Dufferin (Orangeville)	13,318	36,506	13,906	38,116	15,119	41,440
Elgin (St. Thomas)	28,349	73,298	29,600	76,531	32,181	83,206
Essex (Windsor)	129,115	333,730	134,810	348,451	146,567	378,838
Frontenac (Kingston)	58,111	126,447	60,674	132,024	65,965	143,538
Grey (Owen Sound)	37,718	79,638	39,382	83,151	42,816	90,402
Haliburton	19,291	12,657	20,142	13,215	21,899	14,368
Hastings (Belleville)	51,111	112,574	53,365	117,540	58,019	127,790
Huron (Goderich)	25,470	58,903	26,594	61,502	28,913	66,865
Kent (Chatham)	43,354	112,506	45,267	117,469	49,214	127,713
Lambton (Sarnia)	52,016	126,654	54,310	132,241	59,046	143,774
Lanark (Perth, Smith Falls)	24,260	52,433	25,330	54,746	27,539	59,520
Leeds & Grenville (Brockville)	40,766	88,124	42,564	92,012	46,276	100,036
Lennox & Addington (Napanee)	15,741	34,965	16,435	36,508	17,868	39,691
Middlesex (London)	147,431	365,131	153,935	381,237	167,359	414,484
Northumberland (Cobourg)	31,077	71,240	32,447	74,383	35,277	80,870
Oxford (Woodstock)	33,148	89,017	34,610	92,943	37,629	101,049
Perth (Stratford)	26,172	70,174	27,326	73,270	29,709	79,660
Peterborough	56,067	111,783	58,540	116,713	63,645	126,892
Prescott & Russell (Hawkesbury)	22,781	62,664	23,786	65,428	25,860	71,134
Prince Edward	10,665	23,092	11,136	24,111	12,107	26,214
Renfrew (Pembroke)	41,910	91,078	43,759	95,095	47,575	103,388
Simcoe (Barrie)	116,626	256,104	121,771	267,401	132,390	290,720
Stormont, Dundas & Glengarry	42,245	108,058	44,108	112,825	47,955	122,664
Victoria (Lindsay)	30,892	58,419	32,255	60,996	35,068	66,315
Wellington (Guelph)	56,824	152,350	59,331	159,070	64,505	172,943
DISTRICTS						
Algoma (S.S. Marie)	51,050	83,252	53,302	86,925	57,951	94,505
Cochrane	35,324	89,905	36,882	93,870	40,098	102,057
Kenora	16,258	37,246	16,975	38,889	18,455	42,280
Manitoulin	5,065	7,175	5,288	7,491	5,750	8,144
Nipissing (North Bay)	31,244	79,047	32,622	82,533	35,467	89,731
Parry Sound	25,081	31,935	26,188	33,344	28,471	36,251
Rainy River	8,653	20,113	9,035	21,000	9,822	22,831
Sudbury	7,872	18,398	8,219	19,210	8,936	20,885
Thunder Bay	59,697	149,355	62,330	155,943	67,766	169,542
Timiskaming	15,974	37,872	16,678	39,542	18,133	42,991
TOTALS	3,856,014	9,598,600	4,026,105	10,022,000	4,377,215	10,896,000